

ENVIRONMENTAL



A Study of Interrelationships

Tenth Edition

Eldon D. Enger Delta College

Bradley F. Smith Western Washington University

with contributions by

Anne Todd Bockarie
Philadelphia University



Boston Burr Ridge, IL Dubuque, IA Madison, WI New York San Francisco St. Louis Bangkok Bogotá Caradas Kuala Lumpur Lisbon London Madrid Mexico City Milan Montreal New Delhi Santlago Seoul Singapore Sydney Taipei Toronto



Note: Figures and tables, indicated by f and t respectively, are cited only when they appear outside related text discussions.

A

A horizon, 312f, 313 abiotic factors, 79 abyssal ecosystems, 125 Acapulco climagraph, 116f accidental deaths, 42 accidents, nuclear, 230–233 acid deposition, 193, 400–403 acid mine drainage, 193 acid rain, 400–403 acids

characteristics, 68, 69f soil formation and, 310 acquired immunodeficiency syndrome (AIDS), 164 activated-sludge sewage treatment, 374 activation energy, 69 active solar systems, 206-207 acute respiratory syndrome (SARS), 90 acute toxicity, 439-440 additives, in food, 344 administrative law, 460-461 aerated piles of compost, 428 aesthetic pollution, 296 Africa

agriculturally suited land, 318t elephant population management, 143 HIV/AIDS and, 164 international water disputes and, 371t oil and gas reserves, 191f soil fertility and hunger, 327 water use, 358f waterbird conservation, 275 African elephant, 143 age distribution, 134-135 defined, 134, 152 of mothers giving birth, 152 U.S., 160-161 Agenda 21, 7, 472 aging populations, public policy and, 165 Agreement on Cooperation for the

Sustainable Development of

the Mekong River Basin, 15

Agreement on the Conservation of African-Eurasian Waterbirds, 275 agricultural middle region of North America, 8-10, 11f agricultural waste, 343, 420, 421t agriculture, 329-351 alternative approaches to, 343-348 biomass and, 208-209, 211 chemical use, 333-343 climate change and, 409 development of, 330-332 erosion and, 315, 316 fertilizer use. See fertilizers fossil fuel vs. muscle power and, 332 global land use patterns, 318t habitat loss and, 145, 256, 259-260, 261f industrial production of livestock, 343 nitrogen cycle and, 98 organic, 344, 345, 349 pesticide use. See pesticides regional environmental concerns, 8-12 soil conservation practices, 316-323, 327 Soviet soil contamination, 341 tillage methods, 320-323 in tropical rainforests, 117 U.S. land use patterns, 317f waste products, 343, 420, 421t. water pollution, 343, 368, 370, 381 water use, 358-359, 360f Agriculture, U.S. Department of, "organic" standards, 349 AIDS (acquired immunodeficiency syndrome), 164 air pollutants carbon monoxide, 391-392 general classes of, 390-397 global warming and, 409 ground-level ozone, 394-397, 417 hazardous, 391, 397 incineration ash, 425-426 lead, 393-394

nitrogen dioxide, 393

sulfur dioxide, 393

particulate matter, 392-393

volatile organic compounds, 394 air pollution, 390 coal-based, 193 control methods, 397-400 fuelwood-based, 212 indoor, 411, 413-414, 415f in Mexico City, 392 policy and personal choice and, 417 pollutants, 390-397 regional issues, 5-6 trash-based, 213 urban growth and, 287 air quality improving, cost-benefit analysis, 48t pollutant standards, 391t U.S. legislation, 459t. See also Clean Air Act, U.S. air stripping, 446 air toxics, 391, 397 airplanes, terrorism and, 229-230 Alaska ANWR-oil industry conflict, 195-196 Exxon Valdez oil spill, 25, 26f, 369 land conservation, 195-196 Alaskan National Interest Lands Conservation Act, 195-196 alewives, 266 ALF (Animal Liberation Front), 36 alpha radiation, 221 alpine tundra, 122 alternative agriculture, 343-348 defined, 344 integrated pest management, 345-348 soil and water protections, 344-345 alternative-fuel vehicles, 183 Amazon extractive reserves, 27 American National Standards Institute (ANSI), 469 Amsterdam Treaty, 473 anaerobic digestion of biomass, 210 Angola, oil exports, 179t Animal Liberation Front (ALF), 36 animal-to-human disease

transmission, 90

ANSI (American National Standards Institute), 469 anthracite, 192 anthrax, 466-467 anthropocentric, 21 antibiotics resistance, 343 aquaculture, 262-264 aquarium trade, 264 aquatic ecosystems, 122 acid rain effects, 401-402 carbon cycle, 97 DDT effects, 338, 339f Everglades National Park, 375 fertilizer effects, 99-100, 368 freshwater. See freshwater ecosystems habitat loss, 260 habitat preservation, 377-378, 380 marine, 122-126 non-native invasive plants, 126 primary succession, 107-108 thermal pollution, 233-234, 235f, 360, 369 wetlands. See wetlands aquicludes, 355, 356f aquifers, 354-355, 356f aquitards, 355, 356f Arab-Israeli War of 1973, oil and, 179 Aral Sea, 379 Arctic National Wildlife Refuge (ANWR), 195-196 Argentina agriculturally suited land, 318t nuclear power reactors, 226t standard of living and population growth, 155f Armenia, nuclear energy production, 226t Army Corps of Engineers, U.S., Everglades restoration plan, 375 Army, U.S., hazardous waste reduction, 446 artesian wells, 355, 356f asbestos, 413t ash disposal and toxicity, 425-426 Asia. See also specific country agriculturally suited land, 318t international water disputes, 3711 nuclear power facilities, 225, 2261, 235, 239-241

water use, 358f nitrogen cycle and, 97–98 phosphorus cycle, 98–99 blue crab fish as pest control agent, 347–348 Biological Diversity, Convention Bay, 3	isease, 192–193 ferret, 271 <i>f</i> hery, in Chesapeake
water use, 358f nitrogen cycle and, 97–98 phosphorus cycle, 98–99 blue crab fish Asian longhorned beetle, 265 as pest control agent, 347–348 Biological Diversity, Convention Bay, 3	hery, in Chesapeake
Asian longhorned beetle, 265 as pest control agent, 347–348 Biological Diversity, Convention Bay, 3	nery, in Chesapeake
, c 1 1 046	
aspen community food web, 94f population growth curve, waste on, 269 bobwhite qua	ail, 272, 273f
1 100	emical oxygen
BOD (block	1), 127, 364, 366f
200 200	er reactors (BWR), 223
acid rain, 400–403 female literacy, fertility, and biological pollutants, 413t bonds	1 reactors (BWK), 223
air quality improvement, cost- GNI, 153f biological services values, chemical,	60
handle solvices values, chemical,	ice type, 52–53
performan	s, 119–120, 121 <i>f</i>
change, 403, 405–411 program, 157 Biological Weapons Convention bottle recycl	
Biological Weapons Convention Dotte recycl	aters Treaty, 6
pollution. See air pollutants; air Basel Convention, 448–449 biomagnification, 338–339 Brazil	alers freaty, o
pollution 1 (0.60)	ncumption 175, 177.
otoms, 55, 55, 206 Chergy Col	nsumption, 175t, 177t
hiococohomical1 07 00 1 1	eracy, fertility, and , 153f
musless Gasing 222, 224	ver plant, 198–199
226 227	ower reactors, 226t
1 6 1 000 0000	n characteristics, 151t
structure of, 67 reactors, 226t developing world and, 176 breast feeding	
ATOT - 11-11-11-11-11-11-11-11-11-11-11-11-1	tors, 226–227
orecaer reach	netic diversity
energy consumption, 175t, 177t beta radiation, 221 biomes, 110–122. See also specific and, 24	
Macquarie Marshes water bioaccumulation, 13, 338–339 biome brood parasi	
diversion, 373 biocentric, 21 defined, 110 brownfields,	
oil and gas reserves, 191f biochemical oxygen demand desert, 111–112, 113f brownfields	development, 298
Austria, electricity consumption (BOD), 127, 364, 366f elevation effects on climate and Bti (Bacillus	thuringiensis
and price, 179t biocides, 334 vegetation, 111, 112f israelie	ensis), 347-348
automobile emissions biodegradable, 46 grassland, 112–114 buffalo of Ko	eoladeo National
controlling, 397–398 biodegradation of hazardous Mediterranean shrubland, Park, Ir	ndia, 6
photochemical smog and, 395 substances, 446 114–116 Bulgaria, nu	clear power
types of, 393, 394, 417 biodiversity, 246–279 savanna, 114, 115 <i>f</i> reactors	
	ge W., Yucca Mountain
alternative fuel, 183 defined, 247 forest/boreal forest, and, 23	
driving habits, 178t ecosystem diversity, 249–250 119–120, 121f bush meat, 2 energy consumption, genetic diversity, 248–249 temperate deciduous forest, butterflies, 2	
Dire (Bloke	ogical Weapons ntion), 467
of the state of th	ng-water reactors), 223
fuel according covernment loss and extinction 247-248 tropical rainforest	ing-water reactors), 225
policy and, 178–179 North American losses, 129 116–118, 313	
hybrid electric designs, 184 preservation, 268-277 tundra, 120-122 C horizon, 3	312f. 313
Mexico City air pollution species diversity, 249, 250t biotechnology, 347–348 Cairo climate	
issues, 392 threats to, 255–268 blotte factors, 79 California	
oil consumption and, 173–174 tropical rainforest biotic potential, 135 drought, v	water use and, 361
urban planning and, 295–297 resources, 117 birds irrigation	
1 1 171 monogoment 067	Community
Sich population management endangered 250 272 2725	servation Planning
OTE OTE	
B image problem in, 277 · 274–275 smoking California c	
7. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1. 1.	Vater Plan, 361
baby boom, 160-161 wildlife population management birth control Cambodia	Mekong River Basin
Bacillus anthracis, 466-467 and, 272-275 for elephants, 143 and, 15	
Bacillus thuringiensis, 347 biodiversity threats, 255–268 for humans, 152 Canada	
	rally suited land, 318r
	Waters Treaty, 6
"Not be Mr. D. A	n losses, 129
report 20	y consumption and e, 179t
bacteria biogeochemical cycles, 95 Committee, 3 energy or	onsumption, 175t, 177t
	taxes, 178

nuclear power reactors, 226t oil exports, 179 population comparisons with Mexico and U.S., 163 cancer, radiation and, 233 carbamates, 335 carbon absorption, 446 carbon cycle, 96-97 carbon dioxide biomass conversion and, 211 Chinese emissions, 200 coal consumption and, 193 as greenhouse gas, 405, 406t nutrient cycles and, 99 carbon monoxide, 391-392, 413t carcinogenic, 393 cardboard, 44 carnivores, 91 carrying capacity, 136-137, 139 human populations and, 141-142, 144 Carson, Rachel, 23 catalysts, 69 Centers for Disease Control (CDC) trade embargo, 90 Central America, water use, 358f CERCLA (Comprehensive Environmental Response, Compensation, and Liability Act), 443-444 CERES (Coalition for Environmentally Responsible Economics) Principles, 26 CFCs. See chlorofluorocarbons chain reaction, nuclear fission, 222, 223f chaparral, 114-116 chemical bonds, 69 chemical reactions, 69-70 in living things, 70, 71f weathering processes, 308 chemical weapons, 467-468 chemical weathering, 308 chemicals aesthetic pollution from, 296 agricultural use, 333-343 food additives, 344 hazardous. See hazardous materials/substances; hazardous wastes household, 66 pesticides. See pesticides synergism, 440 toxic releases, 444, 445f waste management in China, 448 Chernobyl nuclear power plant accident, 230-233 cherry growers, 337, 338f Chesapeake Bay blue crab fishery, 3 Chicago climagraph, 119f agriculturally suited land, 3181

energy consumption and/or production, 1751, 1771, 188, 200-201. 463-464, 465f energy efficiency gains, 411 female literacy, fertility, and GNI, 153f food consumption/ production, 340 hazardous wastes and toxic materials, 448 nuclear power reactors, 225, 2261, 239-241 oil reserves, 191f population characteristics, 151t population policies and outcomes, 154-155 Three Gorges Dam, 217 chlorinated hydrocarbons, 335 chlorofluorocarbons (CFCs) decline in, 470-471 globalization and, 411 as greenhouse gas, 405, 406t ozone depletion and, 403, 471 chronic toxicity, 439-440 CITES (Convention on International Trade in Endangered Animal and Plant Species), 30, 32, 143 cities. See urban centers; urban planning clay, soil texture and, 310 Clean Air Act, U.S. objectives, 400 OMB cost-benefit analysis of, 462 oxygenated fuels under, 75 Clean Water Act benefits, 462, 463f objectives, 360 Clean Water Action Plan, 366, 368 clear-cutting, 257 climate elevation effects on vegetation and, 111, 112f soil formation and, 309-310 climate change, global warming and, 403, 405 addressing, 410-411 causes, 405-407 potential consequences, 407-410 climax communities, 105 biomes. See biomes modern concepts of, 108-110 versus successional communities, 107 Clinton, Bill, environmental executive orders, 28, 29 CNG (compressed natural

gas), 183

categories, 191-192

Chinese resources and consumption, 200 consumption, 172, 173f, 187f extraction issues, 192-193 formation, 189-190 global recoverable reserves, 190/ coal mining, 192-193, 422 Coalition for Environmentally Responsible Economics (CERES) Principles, 26 coastal sage scrub habitat destruction and protection, 245 coevolution, 85 cogeneration of biomass, 210 Cold War, nuclear power and, 242 collared lemming, 140 combustion, 74, 210 command-and-control methods, 461-462, 463/ commensalism, 88, 89f, 90 commercial energy consumption, 175 commercial land-use, planning and, 291 Commission on Civil Rights, U.S., "Not in My Backyard" report, 29 Commission on Sustainable Development (CSD), 471 common property resource problems, 49-50, 470 community, 90 ecosystem interactions, 90-100. See also ecosystem(s) pioneer community, 105 urban growth and the sense of, 287-288 community supported agriculture (CSA) farms, 10 competition, 86-87, 90 competitive exclusion principle, 87 composites, recycling, 432f composting, 428 compounds, 68 volatile organic compounds, 394 Comprehensive Environmental Response, Compensation, and Liability Act (CERCLA), 443-444 compressed natural gas (CNG), 183 computers, disposal of, 444 condors, 275 confined aquifers, 355, 356f conflict management, Keoladeo National Park, 6 coniferous forests, northern,

119-120, 121/

conservation agricultural practices, 316-323, 327 of energy, 213-216 habitat conservation plans, 83 law of conservation of mass, 65 Pennsylvania farmland casement program, 292 of water, 358, 359f conservation legislation/programs Agreement on the Conservation of African-Eurasian Waterbirds, 275 Alasksan National Interest Lands Conservation Act (1980), 195~196 Conservation Security Program, 319 **Natural Community** Conservation Planning Act (California), 245 Pennsylvania Agricultural Conservation Easement Purchase Program, 292 Resource Conservation and Recovery Act (RCRA) of 1976, U.S., 437 U.S. legislation, 459t World Conservation Union, 268 conservation of mass, law of, 65 Conservation Security Program, 319 conservation tillage, 321-323 conservation/management ethic, 24 consumer packaging resins, 427 consumerism, green, 473-474 consumers, 91 consumption, ethics of, 29-32. See also energy consumption; food consumption/ production; oil consumption container laws, 430 contour farming, 319 controlled experiments, 65 conventions Basel Convention, 448-449 Biological Weapons Convention, 467 Convention for the Regulation of Whaling, 470 Convention on Biological Diversity, 269 Convention on International Trade in Endangered Species of Wild Fauna and Flora (CITES), 30, 32, 143 United Nations Convention to Combat Desertification (UNCCD), 318 United Nations Framework Convention on Climate

Change, 32

coral reef ecosystems, 123, 125f corn, genetically modified, 348 corporation(s), 25 environmental ethics, 24-27 extended product responsibility, 54 pollution prevention, 52 State Power Corporation of China, 201 corrosiveness, 437 corrugated cardboard, 44 cost-benefit analysis, 47-48 concerns about, 48, 49f of EPA regulations, 462 costs environmental, 45-47 irrigation methods and, 359, 360f of nuclear reactor decommissioning, 234-236 Council on Environmental Quality (QEC), 461 cover, 272 cowbird population management, 267 crab fishery, in Chesapeake Bay, 3 credit source for poor people, 157 cremation practices, Ganges River and, 367 criteria air pollutants, 391 global warming and, 409 "organic" standards, 349 pest resistance, 347-348 crude oil. See oil; oil consumption crust, 306 Cryptosporidium epidemic, 366 CSA (community supported agriculture) farms, 10 CSD (Commission on Sustainable Development), 471 curbside recycling, 430 cyanide spill, 464-465 cyfluthrin resistance, 341 Czech Republic, nuclear power reactors, 226t D

Dalupiri Ocean Power Plant,
202-203
dams
environmental issues, 109,
199-201
hydroelectric, 198-199, 362
Three Gorges Dam, 217
tidal sites, 202
dandelions, 81-82, 138
daylighting, 206
DDT
biomagnification, 338, 339f
historical perspective on, 334
as persistent pollutant, 440

Soviet soil contamination and, 341 dead zone, Gulf of Mexico, 100, 381 death accidental causes, 42 environmental causes/risks, 40t death phase, 137 death rate, 132-133 debt, environmental, 455, 456f debt-for-nature exchanges, 56 decertification, 211f decibels, 399 deciduous forests, temperate, 118-119 decision-making process, 39-43. See also environmental policy; government/public policy decommissioning of nuclear reactors, 234-236 decomposers, 91 deferred costs, 45 deforestation, 256 greenhouse effect and, 405 habitat loss and, 256-259 in India, 55 tropical, 117, 258-259 demand, 43. See also supply and demographic transition, 159-160 demography, 151 aging populations, public policy and, 165 denitrifying bacteria, 97 density-dependent limiting factors, 139 density-independent limiting factors, 139 deoxyribonucleic acid (DNA), genetically modified organisms and, 347-348 deposit-refund programs, 52 desertification, 260, 261f, 318 deserts, 111-112, 113f dry west region of North America, 10-12 soil profile, 313, 314f design. See product design detergents, as contaminants, 366-368 detritus, 93 deuterium isotopes, nuclear fusion, 227, 228f developing nations. See also lessdeveloped countries; moredeveloped countries biomass fuel consumption, 176 economic-environmental issues,

56-57, 464

nuclear power, 242

urbanization, 283

Montreal Protocol and, 471

water use and pollution, 363

development ethic, 22 Dicrostonyx groenlandicus (collared lemming), 140 diet Chinese, economic development and, 340 inadequate, health outcomes of, 158-159 trophic levels of food consumption, 157-159 direct combustion of biomass, 210 direct gain, 206 disease. See health and disease dispersal, 135 disposal. See solid waste disposal; waste disposal diverse southern region of North America, 14, 16f diversion of water, 372-373 DNA, genetically modified organisms and, 347-348 domestic water use, 357-358, 359f drawdowns, Lake Toho, 61 dredging, 362, 364 drilling operations natural gas, 196 oil, 193-194 drinking water, lead content, 383 driving habits, 178t drought, in Southern California, 361 dry west region of North America, 10 - 12dumps, hazardous waste, 443-444, 445f \mathbf{E} Earth Day, 458

Earth Liberation Front (ELF), 36 Earth Summit, 6-7, 472 ecocentrism, 21 ecolabels, 474 ecology, 78-101 basic concepts, 79-82 community and ecosystem interactions, 90-100 defined, 79 ecological vs. economic systems, 48-49 industrial, 27 natural selection and evolution, 82-86 organism interactions, 86-90 organizational levels, 79f economic growth/development, 24 biodiversity and, 11 Chinese food consumption/production and, 340 climate change issues, 410-411 energy consumption and, 177-182 environmental ethics and, 24

global population, fossil-fuel consumption and economic output, 187t North American immigration trends and, 163 economic value(s) direct, of biodiversity, 254-255 pesticide use and, 343 economic vs. ecological systems, 48-49 economics, 43 developing nations, environment, and, 56-57 environmental context, 43-50 environmental tools, 50-54 female literacy, fertility, and GNI, 152, 153f mercury contamination, 58 of recycling, 431, 432f risk and, 39-43 sustainable development and, 54-56 urban sprawl and, 286 ecosystem(s), 90-130. See also biomes; specific type of ecosystem acid rain effects, 401 biodiversity services values, 250, 254 biogeochemical cycles, 95-100 defined, 7, 91 diversity, 249-250 energy flow through, 92-93 food chains and webs, 93-95 Greater Yellowstone Ecosystem, 10 human impact on nutrient cycles, 99-100 human population growth and, 157-158, 159 keystone species, 92 North American losses, 129 organism roles, 91 succession, 105-110, 114 ecosystem approach, 7-8 ecosystem diversity, 249-250 ecoterrorism, 36, 465-467 ectoparasites, 88 education, population growth and, 152, 153f, 156 Egypt agriculturally suited land, 318t energy consumption, 175t, 177t female literacy, fertility, and GNI, 153f population characteristics, 151t Ehrlich, Paul, 29-30 Eisenhower, Dwight D., 222 electric vehicles, hybrid, 184 electrical energy use, 177. 178-179 electricity. See also nuclear reactors; power plants

geothermal sources, 204

government policy and, 178-179 hydroelectric sources, 197-201 solar sources, 208, 209f tidal sources, 202-203 electrons, 67 elements, 67 elephants, population management, 143 elevation, effects on climate and vegetation, 111, 112f ELF (Earth Liberation Front), 36 emergent plants, 126 Emerson, Ralph Waldo, 23 emigration, 135 emissions auto, 393, 394, 395, 397-398, 417 Chinese CO₂ emissions, 200 particulate matter, 398 power plant, 398-399, 444, 445f tradable permits, fees and taxes, 51 - 52enclosed vessel composting, 428 endangered species, 270 California condor, 275 habitat conservation plans, 83 hot spots, 251-253 international trade in, 30 as medicine sources, 264 North American, 129 overexploitation and, 261-266, 267f purchase prices, 262t support for, image and, 277 by taxonomic group, 272t woodpeckers, 259 Endangered Species Act, U.S., 83 California conservation planning and, 245 passage, exemptions, and amendments, 270 endemism rates, 251-253 endoparasites, 88 endothermic reactions, 69 energy, 70 availability, population growth and, 137, 142 conservation, 213-216 consumption. See energy consumption conversion systems, efficiency rates, 74t laws of thermodynamics, 71-72,73fpublic perceptions, 218 states of matter, 71, 72f types, 70-71, 72f U.S. legislation, 459t energy consumption, 170-185 biomass fuels, 176 Chinese production and,

economics, 177-180 electrical, 177, 178-179 global variations, 174-175 history of, 171-174, 188-189 industrial, 176 residential and commercial, 175 transportation, 176-177, 178t trends, 181-182 energy efficiency Chinese gains, 411 climate change and, 410 urban growth and, 287 energy flow environmental implications, 72 - 74through ecosystems, 92-93 energy sources, 186-219, 197-213 biomass, 208-211 changes in, 173f current availability, 181 defined, 187 fossil fuels. See fossil fuels fuelwood, 211-212 geothermal power, 203-204 hydroelectric power, 197-201 renewable, 197-213 resources vs. reserves, 187-189 solar systems, 206-208, 209f solid waste, 212-213 tidal power, 201-203 wind power, 204-206 Energy, U.S. Department of, nuclear material/waste oversight, 228-229 entropy, 71 environment, 79-80 defined, 5, 79 ecosystem approach to, 7-8 human values and, 20 regulatory issues. See regulation environmental concerns consumption levels, 29-32 economic tools for addressing, 50-54 ethics/morals and, 21-22 interrelatedness of, 5-7 regional, in North America, 8-15, 16f science vs. policy, 6 environmental costs, 45-47 environmental debt, 455, 456f environmental ethics, 19-37 biodiversity values, 255 conservation/management, 24 consumption issues, 29-32 corporate, 24-27 development, 22 ecoterrorism and, 36 environmental justice and, 27-29

ethics vs. morals, 21

global, 32-33

individual, 29, 33

preservation, 22, 24

primary theories of, 21-22 societal, 24 environmental features, land-use planning and, 290 environmental justice, 27-29 environmental justice movement, 28 environmental movement, U.S., 458-460 environmental policy, 452-476 future considerations, 455-457 governance/government and, 454-455 green politics and, 463-465, 466f individual responsibility and, 474 international, 454-455, 468-474 lessons from the past, 455 new challenges, 453-454 regulation and, 460-462, 463f U.S. development of, 457-460 Environmental Protection Agency (EPA) administrative functions, 461, 462f criteria air pollutants, 391t environmental justice highlights, 29 hazardous substances defined by, 436-437 mercury reduction programs, 58 Office of Environmental Justice, 28, 29 OMB cost-benefit analyses, 462 pesticide regulation, 342 pollution-prevention hierarchy, 446, 447f radon testing and, 414 Safe Drinking Water Act and, 464 secondhand smoke recommendations, 404 smart growth awards, 302 water initiatives, 358 environmental protest, 36 environmental racism, 27-29 environmental resistance, 137 environmental science, 5 environmental terrorism, 465-468 Envisioning the Agenda for Water Resources Research in the 21st Century (report), 372 enzymes, 70 erosion mechanical weathering processes, 307-308 mechanisms and outcomes, 315-316, 317f Escherichia coli, 366 estuaries, 125-126 preservation, 378, 380

thermal pollution, 369

ethanol fuels, 75, 210-211 ethics, 21. See also environmental ethics Ethiopia agriculturally suited land, 318t female literacy, fertility, and GNI, 153f population characteristics, 151t ethnic populations, environmental justice and, 27-29 euphotic zone, 122, 127f Eurasian milfoil, 265 Europe agriculturally suited land, 318t demography, aging populations, and public policy, 165 energy consumption trends, 181-182 gasoline taxes, 178 hazardous waste management, 443 international water disputes, 371t nuclear power facilities, 225, 226t, 235, 239 oil and gas reserves, 191f water use, 358f European Commission (EC), nuclear plant decommissioning policies, 235 European Union (EU) air quality objectives, 391t as endangered species market, 30 environmental policy, 472-473 Kyoto Protocol/Treaty and, 178 nuclear power and, 239 eutrophic lakes, 127 eutrophication, 365 evapotranspiration, 354 Everglades National Park, restoration, 375 evolution, 84 genes, natural selection, and, 82-86 of hazardous wastes management program, 449 patterns in, 84-86 executive branch, U.S., 28, 29, 457 exothermic reactions, 69 exotic species communicable diseases, 90 introduction, biodiversity and, 264-266, 267f experiments, 65 exploitation, 24, 261-266 exponential growth phase, 136 exposure limits for hazardous materials, 439. See also hazardous materials/substances; hazardous wastes

200-201

autanded aradust responsibility
extended product responsibility, 53-54
external costs, 45
extinction, 85, 247
causes, 247-248, 255, 256f
human activity and, 247-248
extractive reserves of Amazon, 27
Exxon Valdez oil spill, 25, 26f, 369
F
r
Fairbanks climagraph, 121f
family planning in China,
154–155
farming. See agriculture; fertilizers
farmland
loss of, urban growth and,
288, 289 <i>f</i>
Pennsylvania preservation
program, 292
fecal coliform bacteria, 366
Federal Administrative Procedure
Act. 460–461
Federal Water Pollution Control
Act. See Clean Water Act
Federal Wild and Scenic Rivers
Act, U.S., 377–378
feeding behavior of lesser snow
goose, 145
fees, as market-based instrument,
51–52
female literacy rate, 152, 153f
ferret, blackfooted, 271f
fertility rate
defined, 151-152
population growth factors and,
152–155
fertilizers
alternatives to, 98
content, 99
environmental impact, 99–100,
332–333, 345, 368
leguminous trees and, 327 manure as, 343
filter system, trickling, 374
Finland
electricity consumption and
price, 179 <i>t</i>
nuclear power reactors, 226t
first law of thermodynamics, 71
Fish and Game, California
Department of, 245
Fish and Wildlife Service, U.S. California conservation
planning and, 245
gray wolf population
management, 17
owl habitat litigation, 268
fish populations
Great Lakes, food chain

fisheries Chesapeake Bay blue crab decline, 3 global harvest trends, 263f global production trends, 262f Gulf of Mexico hypoxia and, 381 invasive species, 265-266, 387 Lake Toho drawdowns and, 61 mercury poisoning, 441 overexploitation, 261-264 sustainable management, 276 whale, 34, 470 fission nuclear reactors breeder type, 226-227 standard type, 222-225, 226t fissionable, 222 flex-fuel, automotive use, 183 insecticide resistance, 451 pest control techniques, 345-346 flood control climate change and, 409 Three Gorges Dam and, 217 flooding in Bangladesh, 55 global warming and, 408 storm-water runoff and, 371 urban growth and, 288, 289f floodplain zoning ordinances, 289 floodplains, urban growth and, 288-289 flora. See plants Florida Everglades National Park, 375 Lake Toho drawdowns, 61 fluorescent lighting, 213-214 food additives, 344 food chains, 93-95 Great Lakes contaminants, 95 methylmercury in, 441 food consumption/production in Africa, 327 Chinese economy and, 340 climate change and, 409 ethics, 31 human population growth and, 156-159 "organic" standards, 349 pesticide use and, 343 wildlife harvests, 264 food webs, 93, 94f forest(s). See also rainforests acid rain effects, 401 area, changes in, 257f climate change and, 409, 410f ecosystem services, 256 invasive diseases/infestations, 265 management practices, habitat loss and, 256-259, 268 regional environmental concerns, 12, 13f

soil, 313, 314f taiga/northern coniferous/boreal. 119-120, 121f temperate deciduous, 118-119 tropical dry, 116 west region of North America, 12, 13f Forest Service, U.S., northern spotted owl and, 268 forested west region of North America, 12, 13f formaldehyde, 413t fossil fuels, 172. See also specific fuel agricultural use, 332 air pollution and, 398 burning, nutrient cycles and, 99 in carbon cycle, 97 consumption, 187t, 191-197 formation and distribution, 189-190, 191f Industrial Revolution and, 172 - 173reserves, 188 France demography, aging populations, and public policy, 165 energy consumption, 175t, 177t female literacy, fertility, and GNI, 153f gasoline taxes, 178f nuclear power reactors, 225, 226t population characteristics, 151t tidal power plant, 202 free markets, nuclear power and, 242 free-living nitrogen-fixing bacteria, 97 freeze-thaw cycles, 307 freshwater ecosystems, 126-128 California Water Plan and, 361 defined, 122 Everglades National Park, 375 exotic species introduction, 265-266, 267f fisheries regulation, 276 lakes and ponds, 126-127 non-native invasive plants, 126 resources, 353-354 streams and rivers, 127-128 friable, 310 fruitflies, pest control techniques, 345-346 fuel cell technology, 184, 214t, 215-216 fuel economy, government policy and, 178-179 fuels. See also fossil fuels; nuclear energy for alternative-fuel vehicles, 183 biofuels, 75, 210-211

biomass consumption in developing nations, 176 fuelwood, 211-212 fungi, as pests, 336-337 fungicides, 333, 337 fusion technology, 227, 228f

G

Galápagos tortoise, 271f Gallup Organization poll of public perceptions of energy, 218 game management biodiversity and, 266-267 Leopold, Aldo and, 23 sustainable approach to, 272-275 gamma radiation, 221 Ganges River contamination, 367 GAO hazardous waste landfill study, 28 Garrison Diversion Unit, 372-373 gas-cooled reactor (GCR), 223, 224f gasification of biomass, 210 gasoline lead exposure from, 394 price fluctuation factors, 188-189 taxes, 178, 475 GCR (gas-cooled reactor), 223, 224f General Accounting Office, U.S., hazardous waste landfill study, 28 genes, natural selection and evolution, 82-86 genetic combinations, 249 genetic diversity, 248-249 genetic engineering, 347-348 genetically modified organisms, 347-348 geology geologic processes, 306-308 land-use planning and, 290 Georgia Office of Quality Growth, 302 Georgia-Pacific Corporation, 54 geothermal energy, 203-204 Germany electricity consumption and price, 179t energy consumption, 175t, 177t female literacy, fertility, and GNI, 153f gasoline taxes, 178f nuclear power reactors, 225, 226t, 239 population characteristics, 151t giant panda, 271f glaciation, weathering and, 307, 308 global environmental ethics,

I-6

contaminants, 95

sustainable management of,

thermal pollution and, 369

mercury poisoning, 441

275-276

INDEX

Greater Yellowstone
Ecosystem, 10
green consumerism, 473-474
Green Revolution, 332
greenhouse effect, 405
greenhouse gases, 403, 405-407
Kyoto Protocol and, 412
reservoirs as sources of, 199
GRI (Global Reporting
Initiative), 26
gross national income (GNI), 156
female literacy, fertility
and, 153f
ground-level ozone, 394-397, 417
groundwater, 354
agricultural contamination, 343
aquifers, 354-355, 356f
pollution, 369–371
groundwater mining,
376–377, 378 <i>f</i>
growth. See population growth
Guinn, Kenny, 237
Gulf of Mexico dead zone,
100, 381
Gulf War, 465–466, 467 <i>f</i> Gwich'in, ANWR drilling
and, 196
Gymnogyps californianus
(California condor), 275
gypsy moth, 138, 265
H
п

habitat, 80 conservation plans, 83 endangered, hot spots, 251-253 management, 272 niche and, 80-82 preservation, U.S., 270, 377-378, 380 wildlife, water-use planning and, 373 habitat loss/destruction, 255-261 agriculture and, 256, 259-260, 261f aquatic ecosystem, 260 forestry and, 256-259, 268 lesser snow goose and, 145 overexploitation and, 261-266, 267f urban and industrial land use and, 260-261 habitat management, 272 half-life, radioactive, 221 Hanford nuclear facility, 240 harvesting practices African elephants and, 143 fisheries, 261-264 gray whale controversy, 34 logging, impact of, 117, 257-258 northern spotted owl and, 268 wildlife and plants, 264 Hawaii, land use program, 293, 294f

hazardous, 437 hazardous air pollutants (HAP), 391, 397 hazardous materials/substances, 436 acute and chronic toxicity, 439-440 in China, 448 definitions, 436-437 environmental concerns, 436 exposure limits, setting, 439 identification, 438-439 life cycle, 436f persistent and nonpersistent, 440 regulatory issues, 438-440 synergism, 440 top 20 substances of 2003, 442t U.S. legislation, 459t hazardous waste dumps, 443-444, 445f hazardous wastes, 437 Aral Sea dust, 379 in China, 448 defining, 437 dumps, 443-444, 445f environmental effects, 440-441 environmental justice and, 27 - 29Ganges River contamination, 367 health risks associated with, 442 household sources and behaviors, 450 identification, 438-439 inner-city redevelopment and, 297-299 international trade in, 447-449 Lake Champlain, 387 management options, 444-447 management program evolution, 449 persistent pollutants, 440 radioactive, 229, 233, 236-238, 240 sources, 438 Soviet soil contamination, 341 synergism, 440 HDPE (high-density polyethylene), 427 health and disease agricultural antibiotics and, 343 Aral Sea and, 379 biomass consumption and, 176 black lung disease, 192-193 carbon monoxide effects, 391-392 climate change and, 409 exotic species and, 90, 265 fecal waste and, 366 global warming and, 409 Great Lakes contaminants and, 95 hazardous waste effects, 442

HIV/AIDS, 164 household chemicals and, 66 inadequate diet and, 158 lead exposure and, 383, 393-394, 441 particulate matter effects, 393 persistent pollutants and, 440 pesticides and, 342, 343 radiation effects, 232, 233, 234f radon effects, 414 standard of living and, 156 sulfur dioxide effects, 393 energy flow, 72-73, 74, 92-93 geothermal, 203-204 latent, 71 as nuclear fission product, 222-223 sensible, 71 solar, 206-207 thermal pollution, 233-234, 235f, 360, 369 heavy metals, as persistent pollutants, 440 heavy-water reactors (HWR), 223 helium-4, 228f herbicide resistance, 348 herbicides, 333, 335-336 herbivores, 91 carbon cycle and, 96-97 humans and, 89-90 high-density polyethylene (HDPE), 427 high-level radioactive waste, 236-237 Hindus, Ganges River and, 367 HIV (human immunodeficiency virus), 164 horizons (soil profile), 312-315 host, 87 host-parasite relationships, 87-88, 89, 90 Hot Dry Rock Project, 204 hot spots of biodiversity, 251-253 houseflies, 341 household chemicals, 66 household hazardous wastes, 450 housing indoor pollution, 411, 413-414, 415f land-use planning and, 291 radon and, 414-415 .urban-to-suburban shift and sprawl, 284-285 human immunodeficiency virus (HIV), 164 human population(s), 148-167 age distributions, 134f, 135 air pollution, personal choice and, 417 biodiversity and, 11, 255 earrying capacity, factors

affecting, 141-142, 144

human population(s)—Cont.
demography, aging populations,
public policy and, 165
economic output, fossil-fuel
consumption and, 187t
environmental policy and, 453
environmental values, 20
global characteristics and
implications, 149-150
health. See health and disease
HIV/AIDS impact on, 164
hydrologic cycle and, 355-356
individual responsibility, 29,
33, 474
nonhuman organism
interactions, 89–90
North American
comparisons, 163
nutrient cycles and, 99-100
soil degradation and, 326
species extinction and, 247-248
United States trends, 160–162
urbanization of, 160
human population growth,
140–142, 144
demographic transition,
159–160
doubling time, 141, 142f
factors influencing, 150-155
hunger, food production,
environmental degradation
and, 156–159
likely consequences, 162
Malthus essay on, 150
poverty and, 156
standard of living and,
155–156
human waste contaminants, 366
Humane Society of United States,
elephant population
management strategy, 143
humus, 309 Hungary
cyanide spill effects, 464–465
nuclear power reactors, 226t
hunger
in Africa, soil fertility and, 327
human population growth and,
156-159
hunting. See harvesting practices
Hussein, Saddam, 465-466
HWR (heavy-water reactors), 223
hybrid electric vehicles, 184
hydrocarbons, 335, 394
hydroelectric power, 197-201
climate change and, 408
environmental effects, 199-201
in-stream water use and,
360, 362 Three Gorges Dam, 217
hydrogen economy, 183,
214-216
hydrogen ions, 68
hydrogen isotopes, 67, 227, 228f

hydrologic cycle, 354–355 climate change and, 407-409 human influences on, 355-356 hydroxide ions, 68 hypotheses, 64-65 hypoxia, in Gulf of Mexico, 381 ice, as weathering agent, 307-308 ignitability, 436-437 image, endangered species and, 277 immigration, 135 demography, aging populations, public policy and, 165 North American, effects of, 163 population growth and, 155 U.S. population policy and trends, 161-162 impoundments, water pollution and, 370 incineration, 424-426, 446-447 India deforestation effects, 55 energy consumption, 175t, 177t female literacy, fertility, and GNI, 153f Ganges River contamination, 367 Keoladeo National Park, 6 nuclear power reactors, 226t population characteristics, 151t population policies and outcomes, 155 India Wildlife Protection Act, 6 individual responsibility, 29, 33, 474 Indonesia female literacy, fertility, and GNI, 153f population characteristics, 151t indoor air pollution, 411, 413-414, 415f industrial ecology, 27 industrial nations, water use and pollution, 363 industrial northeast region of North America, 12-14 Industrial Revolution, fossil fuels and, 172-173 industrial solid waste, 420, 421t industrial water use, 359-360, 363 global, 358f pollution, 363, 368-369 industry Chinese, waste issues, 448 energy use, 176 site use, habitat loss and, 260-261 solid waste, 420, 421t toxic chemical releases, 444, 445f water-based conflicts, 13-14

infant mortality, 156

infectious disease, 90 information programs, 51 infrastructure, 288 land-use planning and, 292 urban growth and, 288 urban sprawl and, 286 inner-city redevelopment, 297-299 inorganic matter, 68 insecticides, 334-335. See also DDT; pesticides defined, 333 new generation, 337 nontarget organisms and, 341-342 resistance to, 339-341, 451 insects, pest management and, 346-348 in-stream water use, 360, 362, 364 integrated pest management, 345 beneficial organisms, 346-347 developing resistant crops, 347-348 disrupting reproduction, 345-346 modifying farming practices, 348 selective use of pesticides, 348 Intergovernmental Panel on Climate Change (IPCC), 405 international environmental policy, 454-455, 468-474 Earth Summit (UNCED), 6-7,472European Union and, 472-473 green politics and, 463-465, 466f International Whaling Commission, 470 ISO standards, 469 new instruments, 473-474 International Joint Commission, 6 International Organization for Standardization (ISO), 469 international trade in diseased species, 90 in endangered species, 30 in hazardous wastes, 447-449 ISO standards and, 469 international treaties, 32, 468, 470, 473t. See also specific treaty International Tropical Timber Agreement (ITTO), 32 International Whaling Commission, 34, 470 interspecific competition, 87 intraspecific competition, 87 Inupiat Eskimos, ANWR drilling and, 196 invasive species, 138 aquatic plants, 126 in fisheries, 265-266 in Lake Champlain, 387 threatened species and, 264-265

ions, 67 IPCC (Intergovernmental Panel on Climate Change), 405 female literacy, fertility, and GNI, 153f nuclear power reactors, 226t population characteristics, 151t Iraqi oil exports, 179 Iraq-Kuwait war, 465-466, 467f Ireland, shopping bag tax, 433 irrigation Aral Sea and, 379 California Water Plan and, 361 Garrison Diversion Unit and, 372-373 methods and costs, 359, 360f salinization and, 376, 377f ISO (International Organization for Standardization), 469 isotopes, 67 nuclear fusion and, 227, 228f radioactive half-lives, 221 Itaipu power plant, 198-199 Italy, gasoline taxes, 178f ITTO (International Tropical Timber Agreement), 32 **IUCN** (World Conservation Union), 268 ivory ban, 143 J Japan electricity consumption and price, 179t

agriculturally suited land, 318t as endangered species market, 30 energy consumption, 175t, 177t female literacy, fertility, and GNI, 153f gasoline taxes, 178 nuclear power reactors, 225, 226t, 241 population characteristics, 1511

judicial branch, U.S., 457

justice, environmental, 27-29

K

Kenya agriculturally suited land, 318t standard of living and population growth, 155f Keoladeo National Park, India, 6 keystone species, 92 kinetic energy, 70 kinetic molecular theory, 65 Kirkland's warblers, 267 Kissimmee River, 375 . K-Mart, 431 Korea. See North Korea; South Korea K-strategists, 139, 140 kudzu vine, 138

Gulf War oil spill, 466, 467f Iraqi invasion of, oil production during, 179	
oil exports, 179 Kyoto Conference on Climate	
Change, 7 Kyoto Protocol/Treaty, 7, 32, 412	
automobile industry and, 178 ratification status, 463 structure, 473	
L	
La Rance generating plant, 202 labels	
ecolabels, 474	
organic food, 349 labor-intensive agriculture, 330–331	
ladybird beetles (ladybug), as pest]
control agents, 346 lag phase, 136	
Lake Champlain, threats to, 387	
Lake Toho (Tohopekaliga), 61 lakes]
acid rain effects, 401-402	
contaminants, 13, 95, 387	1
drawdowns, 61 ecosystems, 126–127	I
eutrophic, 127	1
international water	•
disputes, 371	
introduced species, effects of, 265–266	
oligotrophic, 127	
land, 308	
purchase, as planning	
strategy, 294 settling effects of groundwater	I
mining, 376–377 soil and, 308–309	•
land disposal of hazardous wastes, 447	la
"The Land Ethic," 22	L
land use	L
alterations, land-use planning	
and, 291	le
biomass technology and, 211 California concerns and	le
approaches, 245	le
capability classes, 324–325	
city-to-suburb migration and, 283-285	
conflicts and solutions, 300-301	
habitat conservation, 83	le
North American, historical	le
factors, 281, 282f purchasing rights to, 294	le
soil conservation practices,	10
316–323, 327	
urban and industrial, habitat	
loss and, 260–261 U.S. agriculture, 317f	le
U.S. legislation, 459t	10

Kuwait

land-use planning, 280-304 aesthetic pollution and, 296 city-to-suburb migration and, 283-285 defined, 290 EPA smart growth awards, 302 federal issues, U.S., 299-301 implementation mechanisms, 292-295 lack of, urban growth and, 287-290 Louisiana wetlands plan, 291 need for, 281 Pennsylvania farmland preservation, 292 principles, 290-292 sprawl factors and, 285-287 strategies, 293t urban issues, 287-290, 295-299 landfills, 423-424, 425f, 426f hazardous waste disposal, 28, 447 water pollution, 370 Lao People's Democratic Republic, Mekong River Basin and, 15 latent heat, 71 Latin America, oil and gas reserves, 191f law(s). See also regulation administrative law, 460-461 of conservation of mass, 65 recycling, 430 scientific, 65 smoking, 404 of thermodynamics, 71-72, 73f U.S. passage of, 458 zoning, 286, 294-295 Law of Pollution Prevention and Control of Solid Wastes (China), 448 awsuits, habitat protection, 268, 270 D₅₀, 439 DPE (low-density polyethylene) films, 427 eachate, 423 eaching, 313 ead in drinking water, 383 health effects, 441 as indoor pollutant, 413t as military contaminant, 446 particulates, 393-394 eaf biomass, soil fertility and, 327 gal protection, biodiversity preservation and, 269-272 gislation. See conservation legislation/programs; government/public policy; specific legislative act gislative branch, U.S., 457 guminous trees, soil fertility

and, 327

lemming population fluctuations, 140 Leopold, Aldo, 21-22, 23 less-developed countries, 149 energy consumption, 174-175 fuelwood use, 211 Grameen microcredit program, 157 population growth factors. 151-155 lesser snow goose, 145 lethal dose, 439 Levitt, William, 284 Levittown, New York, 284 life cycle analysis, 53 life cycle of toxins, 436f lifestyle urban sprawl and, 286 waste generation and, 422f lighting daylighting, 206 fluorescent, 213-214 light-water reactors (LWR), 223 lignite coal, 191-192 limiting factors, 80, 81f, 364 carrying capacity and, 137 density-dependent/ independent, 139 limnetic zone, 126, 127f liquefied natural gas, 196 liquid metal fast-breeder reactor (LMFBR), 227 literacy rate, female, 152, 153f lithosphere, 306 Lithuania, nuclear power reactors, 226t litter, 313 littoral zone, 126, 127f Livable Communities Act (Minneapolis-St. Paul), 302 livestock industrial production, 343 "organic" standards, 349 LMFBR (liquid metal fast-breeder reactor), 227 loam, 310 loan programs, 157 log phase, 136 logging environmental impact, 257-258 northern spotted owl and, 268 tropical rainforest, 117 London smog, 393 Los Alamos National Laboratory, heat mining, 204 Louisiana, wetlands loss, 291 low-density polyethylene (LDPE) films, 427 low-level radioactive waste, 229, 237-238 Loxodonta africana (African elephant), 143

LWR (light-water reactors), 223

Lythrum salicaria (purple loosestrife), 346-347

M

Macquarie Marshes water diversion, 373 macronutrients, 333 maize, soil fertility practice utilizing, 327 Makah Tribe of Neah Bay, 34 male sterilization, 345-346 Malthus, Thomas Robert, 150 management/conservation ethic, 24 mandatory recycling laws, 430 mangrove swamp ecosystems, 123, 125 mantle, 306 manufacturing, source reduction and, 429 manure, 343 marine ecosystems, 122 benthic, 122-125 estuaries, 125-126 pelagic, 122, 123f marine fisheries overexploitation, 261-262, 263f regulation, 276 marine oil pollution, 369 market-based instruments, 51-54 marshes, 128 Maryland, blue crab seafood fishery, 3 mass burn, 424-425 mass transit, 295-297 matter, 67 acids, bases, and pH, 68, 69f atomic structure, 67 chemical reactions, 69-70, 71f inorganic and organic, 68-69 molecular nature, 67-68 states of, 71, 72f mechanical weathering, 307-308 mechanized agriculture, 331-332 medicines, endangered sources of, 264 Mediterranean shrublands. 114-116 megalopolis, 285 Mekong River Delta, regional plan, 15 Mendes Filho, "Chico" Alves, 27 mercury contamination economics and risks, 58 health effects, 441 Lake Champlain, 387 mesosphere, 389 metals persistent pollutants, 440 toxic releases, 444, 445f methane, 406-407 methane digesters, 209f methanol/flex-fuel, automotive

use, 183

methylmercury, 441	Louisiana wetlands losses	Nairobi climagraph, 115f	NIMBY ("not in my backyard"),
metropolitan areas. See urban	and, 291	natality, 132	25, 29
centers	Missouri River, Garrison	National Environmental Policy	nitrifying bacteria, 97
Mexico	Diversion Unit and, 372–373	Act (NEPA), 461	nitrogen cycle, 97-98
ecosystem losses, 129	mixture, 68	National Law Journal study of	nitrogen dioxide, 393, 413t
energy consumption, 175t, 177t	moderator (nuclear reactor), 222	waste and minority	nitrogen-fixing bacteria, 97
female literacy, fertility, and	molecules, 65, 67-68	communities, 28–29	nitrogen-fixing plants, 327, 345
GNI, 153f	monkeypox, 90	National Priorities List, 443, 444	nitrogen, hypoxia-causing, 381
nuclear power reactors, 226t	Mono Lake, wildlife habitat	National Research Council report	nitrogen monoxide, 393
oil exports, 179t	and, 373	on water resources, 372	nitrous oxide, 406t, 407
population characteristics, 151t	monoculture, 331	Native Americans	noise
population comparisons with	Monterey Regional Water	ANWR drilling and, 196	land-use planning and, 296
Canada and U.S., 163		_	U.S. legislation, 459 <i>t</i>
Mexico City	Pollution Control Agency	bison and, 269	Noise Control Act of 1972, 399
air pollution, 392	(MRWPCA), 359	Natural Community Conservation	
-	Montreal Protocol on Substances	Planning Act, 245	noise pollution, 399
water management, 358	That Deplete the	natural gas	nongovernmental organizations
microcredit programs, 157	Stratospheric Ozone Layer	compressed, automotive	(NGOs), 455, 458–459
micronutrients, 333	(UN), 32, 403, 470–471, 473	use, 183	non-native invasive species, 126
microorganisms, as	morals, 21	consumption, 173 <i>f</i> , 174, 187 <i>f</i>	nonpersistent pesticides, 334
pollutants, 413r	more-developed countries, 149	extraction, transport, and use	nonpersistent pollutants, 440
Middle East. See also	energy consumption, 174-175	issues, 196–197	nonpoint source, 365-366
Organization of Petroleum	population growth factors,	formation, 190	nonrenewable energy sources, 187
Exporting Countries	151–155	global reserves, 191f, 196–197	nonrenewable resources, 43
international water	mortality, 156	Louisiana wetlands losses	nontarget organisms, 334,
disputes, 371t	mortality rates, 132-133	and, 291	341–342
oil and gas reserves, 191f	Moscow climagraph, 121f	natural predators, as pest control	North America
migration	mosquitoes, management	agents, 346–347	agriculturally suited land, 318t
genetic diversity and, 248	technique, 347	natural resources, 43	ecosystem losses, 129
rural-to-urban shift, 281,	moss habitat, 81f	African elephant as, 143	energy consumption trends,
282f, 283	moths	assigning value to, 45	181=182
urban-to-suburban shift,	invasive species, 138, 265	California legislation	international water
283-285	pest control techniques,	affecting, 245	disputes, 371t
migratory birds, management	345, 347	natural selection, 84	land use history, 281, 282f
issues, 274-275	motor vehicle emissions. See	conditions and processes, 84	nuclear power plants, 225f
milfoil, Eurasian, 265	automobile emissions	evolution and, 82-86	oil and gas reserves, 191f
military, U.S., hazardous waste	mountain top removal, 422	naturalist philosophers, 23	population comparisons, 163
reduction, 446	MRWPCA (Monterey Regional	nature centers, 297	regional environmental
Milwaukee, water	Water Pollution Control	nature, views of, 20	concerns, 8–15, 16f
contamination, 366	Agency), 359	Nauru (island), phosphate mining	transportation energy
mine tailings, 233, 234f	MSW (municipal solid waste),	effects, 101	consumption, 176–177
minimization of waste, 446	420–421, 422f, 423f	navigation, climate change	urban sprawl, 283–287
mining	Muir, John, 23, 24	and, 408	water use, 358f
coal, 192–193	mulch, 426, 428	Neah Bay, gray whale harvest, 34	North Korea, nuclear
groundwater, 376–377, 378f	mulch tillage, 321, 322t	negligible risk, 41	reactors, 226t
heat, 204	municipal solid waste (MSW),	NEPA (National Environmental	northeast region of North
on island of Nauru, 101	420-421, 422f, 423f	Policy Act), 461	America, 12–14
mountain top removal, 422	municipal solid waste landfill,	nest parasitism, 89	northern coniferous/boreal forests,
toxic chemical releases,	423–424, 425 <i>f</i> , 426 <i>f</i>	Netherlands, nuclear energy	
	municipal water pollution,	production, 226t	119–120, 121f
444, 445 <i>f</i>	366–368	neutralization of hazardous	northern population cycles, 140
tropical rainforest, 117	muscle power, agricultural	substances, 446	northern spotted owl, 268
uranium, 228, 233, 234f	use, 332	neutrons, 67, 222, 223f	Norway, oil exports, 179
water pollution and, 368–369	Mustela ermina (shorttail	New York City	"not in my backyard," 25, 29
mining waste, 420, 421t	weasel), 140	municipal waste disposal, 421	no-till farming, 322
Minnesota	mutations, 248	watersheds, 372	nuclear breeder reactors, 226–227
Minneapolis-St. Paul smart	genetic diversity and, 248–249	NGOs (nongovernmental	nuclear chain reaction, 222, 223f
growth programs, 302			nuclear energy, 220–243
wind and nuclear power	radiation causing, 233	organizations), 455, 458-459	consumption, 173f, 187f
usage, 169	mutualism, 88–89, 90		development, 222
minorities, environmental racism	Muynak, Uzbekistan, 379	niche, 80–82	fuel cycle, 227–228, 229f, 233
and, 27–29	mycorrhizae, 89	Nigeria	fusion technology, 227, 228f
mission blue butterfly, 271f	N	female literacy, fertility, and	future of, 242
Mississippi River	일 하는 사람들은 경우를 받으면 하는 것이 되었다.	ONI, 153f	nature of, 221–222
Gulf of Mexico dead zone and, 100, 381	NAA (naphthaleneacetic	population characteristics 1514	politics of, 238–241
	acid), 337	population characteristics, 151t	safety concerns, 229-238



ENVIRONMENTAL SCIENCE: A STUDY OF INTERRELATIONSHIPS, TENTH EDITION

Published by McGraw-Hill, a business unit of The McGraw-Hill Companies, Inc., 1221 Avenue of the Americas, New York, NY 10020. Copyright @ 2006, 2004, 2002, 2000, 1998, 1995, 1992, 1989, 1986, 1983 by The McGraw-Hill Companies, Inc. All rights reserved. No part of this publication may be reproduced or distributed in any form or by any means, or stored in a database or retrieval system, without the prior written consent of The McGraw-Hill Companies, Inc., including, but not limited to, in any network or other electronic storage or transmission, or broadcast for distance learning.

Some ancillaries, including electronic and print components, may not be available to customers outside the United States.

This book is printed on recycled, acid-free paper containing 10% postconsumer waste.

1234567890 DOW/DOW 0987654

ISBN 0-07-252829-X

Publisher: Margaret J. Kemp

Senior Developmental Editor: Kathleen R. Loewenberg Outside Developmental Services: Kennie Harris

Marketing Manager: Tami Petsche Senior Project Manager: Mary E. Powers Lead Production Supervisor: Sandy Ludovissy Senior Media Project Manager: Jodi K. Banowetz Senior Media Technology Producer: Jeffry Schmitt

Senior Designer: David W. Hash

Cover/Interior Designer: Jamie E. O'Neal Senior Photo Research Coordinator: Lori Hancock

Photo Research: LouAnn K. Wilson Supplement Producer: Brenda A. Ernzen

Compositor: Cenveo Typeface: 10/12 Times

Printer: R. R. Donnelley Willard, OH

The credits section for this book begins on page C-1 and is considered an extension of the copyright page.

Library of Congress Cataloging-in-Publication Data

Enger, Eldon D.

Environmental science: a study of interrelationships / Eldon D. Enger, Bradley F. Smith. — 10th ed.

Includes bibliographical references and index. ISBN 0-07-252829-X (hard copy : alk. paper)

1. Environmental sciences—Textbooks. 1. Smith, Bradley F. II. Title.

GE105.E54 2006

363.7-dc22

2004019843

www.mhhe.com

PROJECT FOUNDATED

Soviet legacy, 229, 231, 235	oil consumption		
weapons production, 228-229	Chinese, 200	overburden, 192, 422	persistent II
wind power and, 169	as ethical issue, 31	overexploitation, 261-266	persistent pollutants, 440
nuclear fission, 222	global, 187f	aquaculture and, 262-264	persistent trillium, 271f
nuclear fusion, 227, 228f	history of 172	dafin - 1 oca	pest control
nuclear reactors, 222	history of, 172-174, 188-189	exotic species and,	biodiversity effects, 266-267
accidents, 230-233	national per capita energy	261 266 2670	integrated pest management.
Asian, 239-241	consumption equivalents	of marine fisheries,	345–348
breeder-type, 226-227	1/5t, $177t$		pesticides, 333
construction 1	OPEC and, 179-180	261–262, 263 <i>f</i>	bioaccumulation and
construction plans, 224-225	projections, 181	of wildlife and plants, 264	biomagnification, 338-33
decommissioning costs,	U.S. crude imports, 179t	owl habitat, threat to, 268	fungicides and rodenticides,
234–236	oil spills, 195	oxide, nitrous, 406t, 407	336–337
fission-type, 222-225, 226t	Erron V-11 as as	oxides of nitrogen, 393	herbicides, 335–336
global distribution and uranium	Exxon Valdez, 25, 26f, 369	oxygen _	human health concerns, 342
requirements, 226t	1, 400, 40//	atomic structure, 67f	insecticides, 334–335
North American	old-growth temperate rainforests	biochemical oxygen demand,	nontarget error i
distribution, 225f	northern spotted owl and, 268	127, 364, 366f	nontarget organisms and,
plant life extension, 225	Pacific Northwest,	ozone, 403	341–342
radiation exposure, 233, 234f	protecting, 120	depletion, 403	persistent, 337–338
radioactive weets 1	oligotrophic lakes, 127	ground level 204 207 445	resistance to, 339-341
radioactive waste disposal, 229	OMB (Office of Management and	Mexico City and, 392	selective use, 348
236–238, 240	Budget), 462		Soviet soil contamination
as terrorist targets, 229-230	omnivores, 91	Montreal Protocol on, 32, 403,	
thermal pollution,	OPEC. See Organization of	470–471	U.S. legislation, 459t
233–234, 235f	Petroleum Exporting	P	usage changes and rationales,
nuclear weapons, 228-229, 468	Countries	D :=	342–343
nucleus, 67	open space	Pacific Northwest	pests, 333
numbat, 256, 258f		northern spotted owl and, 268	PET (polyethylene terephthalate),
numbers, risk values as, 41	land-use planning and, 290	old-growth rainforests,	427
nutria, Louisiana wetlands losses	urban growth and, 288	protecting, 120	pet trade, 264
and, 291	urban recreation planning and,	packaging resins, 427	petroleum. See oil; oil
utrient cycles	297, 298f	paint, lead exposure from, 394	consumption
	organic agriculture, 344. See also	Pakistan	рН
in ecosystems, 95–99	alternative agriculture	female literacy, fertility, and	characteristics, 68, 69f
human impact on, 99-100	soil and water resources	GNI, 153f	soil formation and, 310
	and, 345	nuclear power reactors, 226t	pheromones, 345
	USDA standards, 349	population characteristics, 151t	Philippines
) horizon, 312f, 313	organic compounds, volatile, 394	panda, 271f	Dalupiri Ocean Power Plant,
bservation, 63	organic food, 349	paper shopping bags, 433	202–203
cean estuaries, thermal	organic matter, 68-69	Paraguay, Itaipu power plant,	
pollution, 369	biogeochemical cycles, 95-99	198–199	female literacy, fertility, and GNI, 153f
ceania, water use, 358f	organism interactions, 86	parasites, 87	
dors, land-use planning	classification challenges, 89	parasitism, 87-88, 89, 90	population characteristics, 151t
and, 296	competition, 86-87, 90	parent material, 309	philosophers, naturalist, 23
ECD (Organization for	human-nonhuman, 89-90	particulate matter, 392–393	phosphates
Economic Cooperation and	population growth and,	particulate matter emissions, 398	mining, on island of
Development), 181	137, 142	passive solar systems, 206	Nauru, 101
ffice of Environmental	predation, 86	patch-work clear-cutting, 258	organophosphates, 335
Justice, 29	symbiotic relationships, 87–89	PCBs (polychlorinated	as wastewater contaminants,
ffice of Management and Budget	organisms	biphenyls), 440	367–368
(OMB), EPA cost-benefit			phosphorus contamination, 387
The second secon	ecosystem roles, 91	peat moss, 190	phosphorus cycle, 98-99
analyses, 462	pesticides and. See pesticides	pelagic ecosystems, 122, 123f	photochemical smog, 394–397
A anti- Maria and Millie D. C.	soil formation and, 309	pelagic organisms, 122	photosynthesis, 70
Arctic National Wildlife Refuge	soil inhabitants, 311–312	pelletising of biomass, 210	photovoltaic cells, 208, 209f
and, 195–196	target vs. nontarget, 334	PEM (proton exchange	phytoplankton, 122
extraction, refinery, and	Organization for Economic	membrane) fuel cells, 215	pioneer community, 105
transport issues, 193–195	Cooperation and	Pennsylvania Agricultural	plankton, 122
formation, 190	Development (OECD), 181	Conservation Easement	planning. See land-use planning;
Louisiana wetlands losses	Organization of Petroleum	Purchase Program, 292	water-use planning
and, 291	Exporting Countries (OPEC)	perceived vs. true risks, 42-43	plantation forestry, 259
marine oil pollution, 369	impact and exports, 179-180,	performance bonds, 52-53	plants. See also biomass
reserves, 188, 191f	181, 182 <i>f</i>	periphyton, 127	aquatic, non-native
as weapon of war,	production rates and	permafrost, 120, 121f	invasive, 126
465–466, 467f	reserves, 188	Persian Gulf, 465–466, 467f	biodiversity hot spots,
World Petroleum Assessment	organophosphates, 335	persistent pesticides, 334.	251-253
2003, 189	outdoor recreation, 300-301	337–338	compost, 428

plants—Cont.	fluctuations, reproductive	scenic water areas and wildlife	radiation exposure
elevation effects on climate and,	strategies and, 139-140	habitats, 377–378, 380	at Chernobyl, 232
111, 112 <i>f</i>	natural selection and evolution,	preservation ethic, 22-24	effects, 221, 233, 234f
global warming and, 409	82–86	pressurized-water reactors (PWR)	radioactive, 221
mulch, 426, 428	size of, genetic diversity	223, 224f, 235t	radioactive half-life, 221
overexploitation, 264	and, 249	prevention of pollution, 47, 52,	radioactive waste
succession and climax	population density, 135, 150	446, 447 <i>f</i>	decommissioning
communities, 105-110	population growth. See also	prey, 86, 346-347	contaminants, 235t
unsustainable harvests, 264	human population growth	price, 43	disposal, 229, 236-238
plastics	factors influencing, 135, 137	of electricity, 178–179	exposure, 233
recycling, 431, 432f	invading species, 138	of gasoline, 178–179, 188–189,	Hanford site, 240
shopping bags, 433	lesser snow goose, 145	475	radon, 413t, 414-415
thermoplastics, resins in, 427	population growth curve, 135–136	of oil, 179-180, 188-189	rainfall
plate tectonics, 306–307	bacterial, 137	of recycled materials,	acid rain, 400-403
plowing, 320, 322 <i>t</i>	human, 140–141	431, 432 <i>f</i>	global warming and, 408
plutonium/plutonium-239	population growth rate, 133	of species, 262t	soil formation and, 310
Hanford facility production and	population management	of water, 357	rainforests
waste, 240	African elephant, 143	primary air pollutants, 390	Pacific Northwest, 120, 268
production, 226	lesser snow goose, 145	primary consumers, 91	temperate, 120
transuranic wastes, 236	wildlife populations, 273-274	primary sewage treatment,	tropical, 116-118, 313
PM _{2.5} , 393	population size, genetic diversity	373–374	ranching, in tropical
PM ₁₀ , 392	and, 249	primary succession, 105	rainforests, 117
point source, 365-366	porosity, 355	aquatic, 107-108	range of tolerance, 80
policy, 457. See also	Portland, OR sewer project, 372	terrestrial, 105-107	rangeland, biodiversity and,
environmental policy;	postwar baby boom, 160-161	probability, 39	259–260, 261 <i>f</i>
government/public policy	potable water, 353	producers, 91	raw materials, population grow
politics. See government/public	potential energy, 70	product design	and, 137, 141
policy	poultry industry, insecticide	hybrid electric vehicles, 184	reactivity, 437
pollution, 46. See also air	resistance in, 341	source reduction, 428-429	reclamation, surface-mine, 192
pollution; water pollution;	poverty	product responsibility,	193f, 422
specific pollutant	human population growth	extended, 54	recreation
aesthetic, 296	and, 156	product standards, ISO and, 469	activities and participation
agricultural, 10, 343, 344, 345 backyard levels, 25, 29	urbanization and, 160 power plants	profitability, corporate ethics and, 25, 26 <i>f</i>	rates, 300
bioaccumulation, 13	emissions, 398–399, 444, 445 <i>f</i>	propane, automotive use, 183	climate change and, 409
corporate ethics and, 24, 25	hydroelectric, 197–201	protests	in-stream water use, 362
inner-city redevelopment and,	nuclear. See nuclear energy;	environmental, 36	land-use conflicts and solutio
297–299	nuclear reactors	hazardous waste, Warren	urban planning, 297, 298f
noise, 399	Prairie Island Mdewakanton	County, NC, 28	U.S. federal lands, 301f
nuclear radiation/waste,	Dakota plant, 169	proton exchange membrane	water-based conflicts with
232, 240	thermal pollution, 369	(PEM) fuel cells, 215	industry, 13–14
prevention techniques, 52	tidal, 202	protons, 67	recycling, 429-431, 432f
sources and impacts, 365t	PP (polypropylene), 427	PS (polystyrene), 427	corrugated cardboard, 44
thermal, 233–234, 235f,	prairie ecosystem, bison in, 269	public policy, 457. See also	of waste, 446
360, 369	Prairie Island Mdewakanton	government/public policy	Red River, Garrison Diversion
pollution costs, 47	Dakota nuclear power plant, 169	public transportation, 176–177 purchase decisions, source	Unit and, 372-373
pollution prevention, 446 pollution-prevention costs, 47	prairies, 112	reduction and, 429	redevelopment of inner-city areas
pollution-prevention hierarchy,	precipitation, as waste treatment,	purple loosestrife, 346–347	297299
446, 447 <i>f</i>	446. See also rainfall	PVC (polyvinyl chloride), 427	refinery processes, oil 104, 105
polychlorinated biphenyls	precision agriculture, 345	PWR (pressurized-water reactors),	refinery processes, oil, 194–195 reforestation, 258
(PCBs), 440	predation, 86	. 223, 224f, 235t	refrigerants, 403, 405
polyculture, 330	predator-prey relationship,	pyrolysis, 210	regional cities, 284-285
polyethylene terephthalate	346–347		regional environmental concerns
(PET), 427	predators, 86, 89, 267		in agricultural middle, 8-10, 11/
polyploidy, 85	preservation	QEC (Council on Environmental	in diverse south, 14, 16f
polypropylene (PP), 427	biodiversity, government/public policy and, 269–272	Quality), 461	in dry west, 10-12
polystyrene (PS), 427 polyvinyl chloride (PVC), 427	ethics, 22-24	quail, 272, 273f questioning and exploring, 63-64	in forested west, 12, 13f
pond ecosystems, 126–127	Everglades National Park, 375		in Great Lakes and industrial northeast, 12–14
population(s), 131-167		R	mannedati 16-14
	habitat conservation, 83	이렇게 되다 하고 있었다. 그는 그 한 경에 되었다. 요 없어요?	Greater Yellowstone
carrying capacity, 136-137, 139		R horizon, 312/	Greater Yellowstone ecosystem, 10
	habitat conservation, 83	그림 집 이 이 이 경험 사람이 하는 하는 것이 없다.	

regional planning agencies,	resources. See also specific		
293–294, 295t	resource	saltwater intrusion, 377, 378f	shrublands, Mediterranean,
regulation. See also specific	consumption as Athical	A Sand County Almanac,	114–116
agency, legislation, program,	issue, 31	21–22, 23	silt, soil texture and, 310
or treaty	defined, 43, 187	sand, soil texture and, 310	Simon, Julian, 30
Basel Convention and,	economic view of, 43	SARS (acute respiratory	Singapore climagraph, 118f
448-449	freshwater, 353–354	syndrome), 90	Single European Act 472
criticisms of, 462f	human population	Saudi Arabia, oil exports, 179-1	80 size limitations, human population
environmental policy and,	human population growth and, 162	savannas, 114, 115 <i>f</i>	growth and, 142, 144
460–462, 463 <i>f</i>		scale infestations, 346	Slovak Republic, nuclear power
of fisheries, 276	Keoladeo National Park, India	, 6 scavengers, humans as, 90	reactors, 226t
of hazardous	nonrenewable, 43	scenic water areas, 377-378, 380	Slovenia, nuclear energy
materials/substances,	reserves versus, 187–189	science, 63	production, 226t
438–440	r-strategists and, 139-140	environmental, 5	smart growth, 299, 302
of hazardous waste,	tragedy of the commons and,	Keoladeo National Park and, 6	smog, 393, 394–397
445–446, 447 <i>f</i>	49–50	limitations, 65–67	smoking concerns, 404, 413
of lead exposure, 383	tropical rainforests, 117	research methods, 63-65	social factors, population growth
of pesticides, 342	U.S. legislation, 459t	scientific knowledge, Keoladeo	and, 142
Safe Drinking Wasse A	respiration, 70	National Park and, 6	societal environmental ethics, 24
Safe Drinking Water Act	reuse, 429	scientific law, 65	soil, 305–328
and, 464	ribbon sprawl, 284	scientific method, 63-65	African soil fertility and
rems, 233	ridge tillage, 321–322	screwworm fly, 345	hunger, 327
renewable energy sources,	Rio Declaration on Environment	sea lamprey, 265-266	alternative agriculture and,
197–213	and Development, 7, 472	sea level, global warming and,	344–345
biomass, 208–211	risk(s), 39	407, 408 <i>f</i>	conservation practices,
defined, 187	characteristics, 39-43	second law of thermodynamics,	316–320, 321 <i>f</i> , 322 <i>f</i>
fuelwood, 211–212	economics and, 39	71–72, 73 <i>f</i>	contamination in Soviet
geothermal power, 203-204	mercury contamination, 58	secondary air pollutants, 390-391	Union, 341
hydroelectric power,	numerical estimates, 41	secondary consumers, 91	defined, 308
197–201	true and perceived, 42–43	secondary recovery of oil, 194	desertification and global
solar systems, 206–208, 209f	risk assessment, 39–40	secondary sewage treatment, 374	security, 318
solid waste, 212–213	risk management, 40–42	secondary succession, 105,	erosion, 315–316, 317f
tidal power, 201–203	risk values, 41	108, 109 <i>f</i>	formation, 309–310
wind power, 204-206	rivers	secondhand smoke, 404	geologic processes, 306-308
renewable resources, 43	ecosystems, 127–128	security (global), desertification	global degradation, 326
replacement fertility, 151–152 reproducibility, 65	in-stream water use and, 360,	and, 318 selective breeding, genetic	land and, 308–309
reproduction	362, 364	diversity and, 249	land capability classes,
disrupting, pest control and,	international disputes, 371 preservation, 377–378	selective harvesting of trees, 258	324–325
345–346	rodenticides, 333, 337	sensible heat, 71	on nonfarm land, 323 properties, 310–312
fertility rate, 151–152	Romania	septic tanks, 370	soil profile, 312–315
genetic diversity and,	cyanide spill, 464, 465	seral stage, 106	soil texture, 310
248–249	nuclear energy production, 226t	sere, 106	tillage methods, 320–323
natural selection and evolution,	Rome climagraph, 115f	services	soil profile, 312–315
82–86	r-strategists, 139-140	biological services values,	soil structure, 310
reproductive strategies and	runoff, 354, 371-372	250, 254	soil texture, 310
population fluctuations,	rural-to-urban shift	forest ecosystem services, 256	solar cells, 208
139–140	in developing nations, 283		solar energy, 206
reserves vs. resources, 187-189.	in North America, 281, 282f	sewage sludge, 374	active systems, 206–207
See also resources; specific	Russia	sewage/sewer issues	electricity generation, 208, 209f
resource	female literacy, fertility, and	sewage treatment, 373–374, 376	passive systems, 206
reservoirs, hydroelectric power	GNI, 153f	William County and Investment Supermental County and Co	solid waste, 420, 421t
and, 197-201	nuclear power reactors,	sex ratio, 133–134	agricultural, 343, 420, 421 <i>t</i> industrial, 420, 421 <i>t</i>
residential energy	225, 226t	sexual reproduction, genetic diversity and, 248–249	mining, 420, 4211
consumption, 175	population characteristics, 151t	SFWM (South Florida Water	municipal, 420–421, 422f, 423f
resins, consumer packaging, 427	S	Management) district, 61	paper vs. plastic bags, 433
resistance	Safe Drinking Water Act, 464	shifting agriculture, 330	per capita production of
to antibiotics, 343 of crops, 347–348	sage scrub habitat destruction and	shipping industry	selected cities, 2127
environmental, 137	protection, 245	Louisiana wetlands losses	radioactive. See radioactive
to herbicides, 348	salinization, 376, 377f	and, 291	waste
to pesticides, 339-341, 451	salmon	water-based conflicts, 13-14	reducing, 429 did waste disposal, 422, 424f
Resource Conservation and	aquaculture, 262-264	Shore types, 120	composting, 428
Recovery Act (RCRA), 437	decline in, 6, 7f		hazardous wastes, 446-447
resource exploitation, 24	introduction to Great Lakes, 266	ationtum regard, the	

	solid waste disposal—Cont.	planning agencies, land-use	Sweden
	incineration, 424–426	planning and,	electricity consumption and
	landfills, 423–424, 425 <i>f</i> , 426 <i>f</i> mining overburden, 422	293–294, 295 <i>t</i> State Power Corporation of China	price, 179 <i>t</i>
	mulching, 426, 428	(SPCC), 201	nuclear power reactors, 226t, 239
	recycling, 429–431, 432f	steppes, 112	Switzerland, nuclear power reactors, 226 <i>t</i>
	source reduction and,	sterilization, 345–346	symbiosis, 87
	428–429	storage tanks (underground), 370	symbiotic nitrogen-fixing
	U.S. legislation, 459t	storm-water runoff, 371–372	bacteria, 97
	sound, noise pollution, 399	stratosphere, 389	symbiotic relationships, 87–89
	source reduction, 428-429, 446	streams	synergism, 440
	South Africa	ecosystems, 127-128	T
	agriculturally suited land, 318t	in-stream water use, 360,	1
	nuclear power reactors, 226t	362, 364	taiga/northern coniferous
	South America	Streptococcus faecalis, 366	forest/boreal forests,
	agriculturally suited land, 318t international water	strip farming, 319–320	119–120, 121 <i>f</i>
	disputes, 371t	strip tillage, 321, 322t Strix occidentalis caurina	tailings, uranium, 233, 234f
	water use, 358f	(northern spotted owl), 268	Taiwan, nuclear power reactors, 226 <i>t</i>
	South Florida Water Management	submerged plants, 126	Tansley, A. G., 7–8
	(SFWM) District	Sub-Saharan Africa, HIV/AIDS	target organisms, 334
	Everglades restoration plan, 375	and, 164	taxation
	Lake Toho project, 61	subsidies, 50-51	gasoline prices and, 178, 475
	South Korea	suburbs, migration to, 283-285.	as market-based instrument,
	electricity consumption and	See also urban centers	51–52
	price, 179t	succession, 105	on plastic shopping bags, 433
	nuclear power construction, 225 nuclear reactors, 226 <i>t</i> , 241	grassland, 114 modern concepts of, 108–110	taxonomic groups endangered and threatened
	southern region of North America,	primary, 105–108	species by, 272t
	14, 16 <i>f</i>	secondary, 108, 109f	numbers of species by, 250t
	Soviet Union	successional stage, 106	taxonomic richness, 249
	Aral Sea and, 379	successional vs. climax	tectonics, 306–307
	nuclear legacy, 229, 231, 235	communities, 107	Tehran climagraph, 113f
	oil and gas reserves, 191f	Suisun, smart growth development, 299	temperate deciduous forests, 118–119
	soil contamination, 341 Spain	sulfur dioxide (SO ₂), 393	temperate rainforests, 120
	electricity consumption and	sulfuric acid, 193	temperature. See global warming,
	price, 179 <i>t</i>	sunspace, 206	climate change and
	gasoline taxes, 178f	Superfund, 443–444	terraces (agricultural), 320, 321f
	nuclear power reactors, 226t	supply and demand, 43–44	terrestrial ecosystems. See biomes
	spatial distribution, 135	supply/demand curve, 43 surface impoundments, 370	terrestrial primary succession, 105–107
	SPCC (State Power Corporation of China), 201	surface mining	terrorism
	speciation, 85	mountain top removal, 422	environmental, 465-468
	species, 83. See also endangered	reclamation issues, 192, 193f	nuclear targets, 229-230
	species; extinction;	survivorship curve, 133	tertiary sewage treatment, 376
	threatened species	Sustainability Reporting	Thailand
	exotic, 90, 264–266, 267f	Guidelines of GRI, 26 sustainable agriculture, 10, 344.	female literacy, fertility, and GNI, 153f
	invading, 138 natural selection and evolution,		Mekong River Basin and, 15
	82–86	agriculture	population characteristics, 151t
	species diversity, 249, 250t	sustainable development, 7, 54	theory, 65
	species richness, 249	economics and, 54–56	thermal inversion, 396, 397f
	sprawl. See urban sprawl	international agreements on, 7 sustainable management of	thermal pollution, 233–234, 235 <i>f</i> , 360, 369
	stable equilibrium phase, 136 standard of living, 155	wildlife populations, 272	thermodynamics, laws of,
	demographic transition and,	fish populations, 275–276	71–72, 73f
	159–160	habitat analysis and,	thermoplastics, 427
	human population growth and,	272, 273f	thermosphere, 389 Thoreau, Henry David, 23
	155–156, 162 starlings, 138	migratory populations, 274–275	threatened species, 268, 270
1	state governments. See also	population assessment and,	invasive species and, 264-265
	specific state	273–274	northern spotted owl, 268
	environmental initiatives: 463	swamps, 123, 125, 128	by taxonomic group, 272t

Three Gorges Dam, 217 Three Mile Island nuclear power plant, 230 3M, pollution prevention, 52 threshold level, 439: tidal power, 201-203 tillage methods, 320-323 time, soil formation and, 309-310 tobacco effects, 404, 413t Tolba, Mustafa, 468 tolerance, range of, 80 topography, soil profile and, 313, 315 Toronto, Canada, municipal waste disposal, 421 tortoise, Galápagos, 271f total fertility rate defined, 151-152 population growth factors and, 152-155 toxic, 437 toxicity, 437 acute and chronic levels of, 439-440 determining levels of, 439 toxins. See also hazardous materials/substances; hazardous wastes; pesticides household chemicals, 66 life cycle of, 436f second hand smoke, 404 toxicity levels, 439-440 tract development, 284 tradable emissions permits, 51 trade in endangered species, 30 tragedy of the commons, 49-50 transportation of coal, 193 land-use planning and, 291-292 mass transit, 295-297 Mexico City air pollution issues, 392 of natural gas, 196 of oil, 195 radioactive material, 228, 233 urban growth and, 287 transportation sector energy consumption, 176-177, 178t Louisiana wetlands losses and, 291 water-based conflicts, 13-14 transuranic wastes, 236 trash. See solid waste treaties, international, 32, 468. 470, 473t. See also specific treaty treatment

of hazardous wastes, 446 of wastewater and sewage, 368,

373-374, 376 trees, leguminous, 327. See also

forest(s)

trickling filter system, 374 trillium, 271f	as endangered species
tritium isotopes, 227, 228f	market, 30
trombe wall, 206	energy conservation, 213–2
trophic levels, 92, 157-159	energy consumption, 175t, 181–182
tropical deforestation, 117, 258–259	environmental movement, 458–460
tropical dry forests, 116	
tropical rainforests, 116–118 soil quality, 313	federal land use issues, 299- female literacy, fertility, and GNI, 153f
use and resources, 117	gasoline taxes, 178, 475
troposphere, 389	geologic radon potential, 41
true vs. perceived risks, 42-43	government. See United State
tundra, 120–122 Turkey	government
	hydroelectric capacity, 198
female literacy, fertility, and	International Whaling
GNI, 153f	Commission and, 470
population characteristics, 151 <i>t</i>	municipal waste production, 420-421, 423f
	nuclear power facilities, 226
Ukraine	234–235, 239, 240
Chernobyl nuclear power plant accident, 230–233	nuclear waste disposal, 236–237, 238
nuclear power reactors, 226t	population characteristics, 15
UNCED, 6-7, 472	population comparisons with
unconfined aquifers, 354, 356f	Canada and Mexico, 16
underground mining, 192	population trends, 160-162,
underground storage tanks, 370	standard of living and
United Church of Christ	population growth, 155j
Commission on Racial	United States government
Justice, 28	biodiversity legislation, 270
United Kingdom	Boundary Waters Treaty, 6
electricity consumption and price, 179 <i>t</i>	branches of, 457
gasoline taxes, 178f, 475	environmental legislation, 45
nuclear power reactors, 226t	environmental policy, 457–460
oil exports, 179	executive branch agencies, 45
United Nations	legislative process, 457–458
Basel Convention, 448-449	uranium
biodiversity preservation	fission, 222, 223f, 226-227
and, 269	global requirements, 226r
environmental programs, 7, 468	Hanford facility production as
international security	waste, 240
issues, 318	mining, 228, 233, 234f
Jnited Nations Conference on	radon and, 414
Environment and	uranium-235, 223f
Development (UNCED),	urban centers
6-7, 472	demise of central city, 288
Inited Nations Convention to	in developing nations, 283
Combat Desertification	energy consumption, 174
(UNCCD), 318	habitat loss and, 260-261
Jnited Nations Framework Convention on Climate	human populations and, 160
Change, 32	poverty and, 160
United States	rural migration to, 281.
agricultural land use, 317f	282f, 283
ambient air quality	solid waste, 212t, 420-421,
standards, 391t	422f, 423f. See also solid
auto industry and oil	waste disposal unplanned growth outcomes,
consumption, 173-174	287–290
crude oil imports, 179t	urban-to-suburban migration.
ecosystem losses, 129	283–285
electricity consumption and	water pollution, 366-368
price, 1791	water-use planning, 371-372

cies on, 213-214 on, 175t, 177t, vement, sues, 299-301 rtility, and 8, 475 tential, 415 **Jnited States** city, 198 ling and, 470 roduction. lities, 226t, , 240 osal, eristics, 151t isons with lexico, 163 160-162, 465 ınd owth, 155f ment tion, 270 reaty, 6 slation, 459t gencies, 457f 457-458 26-227 , 226r duction and 34fy, 288 is, 283 , 174 -261and, 160 81. 0-421, also solid itcomes, igration,

waterways and, 281, 282f urban growth limit, 292 : urban planning recreation issues, 297, 298f redevelopment issues, 297-299 smart growth approach, 299 transportation issues, 295-297 urban sprawl, 284 contributing factors, 285-287 problems associated with, 287-290 smart growth and, 299 types of, 284-285 U.S. Geological Survey (USGS) wastewater contaminants studies, 368 World Petroleum Assessment 2003, 189 USDA (United States Department of Agriculture) "organic" standards, 349 vadose zone, 355, 356f

value(s) assigning to natural resources, 45 of biological and ecosystem services, 250, 254 environmental, 20 risk values, 41 variables, 65 vectors, 88 vegetation. See plants vehicles. See automobiles Venezuela agriculturally suited land, 318t oil exports, 179 vertebrates, biodiversity hot spots, 251-253 Vietnam female literacy, fertility, and GNI, 153f Mekong River Basin and, 15 population characteristics, 1511 viral diseases, animal-to-human transmission, 90 Virginia, blue crab seafood fishery, 3 visual pollution, 296

W

war, impact of, 465-468 warblers, Kirkland's, 267 Warren County (NC), hazardous waste protest, 28 waste. See also hazardous waste; radioactive waste; solid waste corporate ethics and, 24-26 defining, 27 waste accumulation, population growth and, 137

volatile organic compounds

(VOCs), 394, 413t

waste disposal. See also solid waste disposal population growth and, 142 radioactive material, 233, 236-238, 240 U.S. legislation, 459t = waste heat, 233-234, 235f, 360, 369 Waste Isolation Pilot Plant, 236 waste minimization, 446 water, 353-354 active solar systems and, 207 bodies of. See aquatic ecosystems; waterways; specific entity carbon cycle in, 97 conservation methods, 358, 359f erosive actions, 315 global shortages, 353-354 hydrologic cycle, 354-356 lead content, 383 supply and demand, climate change and, 408-409 use. See water use; water-use planning as weathering agent, 307-308 water diversion, 372-373 water pollution, 364-366 agricultural, 343, 368 fertilizer effects, 99-100, 368, 381 Great Lakes and East Coast, 13 groundwater, 369-371 industrial, 368-369 in industrial vs. developing nations, 363 marine oil, 369 municipal, 366-368 thermal, 233-234, 235f, 360, 369 urban growth and, 288, 289f water quality, U.S. legislation, 459t water table, 354 water use agricultural, 344-345, 358-359, 360f categories, 356-357 consumption as ethical issue, 31 domestic use, 357-358, 359f in dry west region of North America, 10-11 global use, 358f industrial use, 359-360 in industrial vs. developing

nations, 363

in nuclear fission,

in-stream use, 360, 362, 364

land-use planning and, 290

222-223, 224/

wastewater treatment, 368,

373-374, 376

U.S. legislation, 459r

waterfowl African-Eurasian conservation agreement, 275 management issues, 274-275 watersheds agriculture and, 345 dam and reservoir impact on, 200-201 New York City, 372 water-use planning, 371-380 groundwater mining and, 376-377, 378f metropolitan services and, 371-372 National Research Council report on, 372 salinization and, 376, 377f for scenic and wild areas, 377-378, 380 wastewater treatment and, 368. 373-374, 376 water diversion and, 372-373 waterways climate change and, 409 in-stream water use and, 360, 362, 364 international disputes, 371t North American land use and, 281, 282f preservation, 377-378, 380 recreational vs. industrial use, 13 - 14soil conservation and, 320, 321f weapons airplanes as, 229-230

biological, 466-468 chemical, 467-468 nuclear, 228-229, 468 oil as, 465-466, 467f weasel (shorttail), 140 weathering processes, 307-308 weeds, 333 wells, artesian, 355, 356f western North America, 10-12, 13f wetlands, 289 Everglades National Park, 375 global warming and, 409 Louisiana losses, 291 preservation, 378, 380 urban growth and, 289-290 Weyerhaeuser Company, 431 whaling International Whaling Commission, 470 Neah Bay controversy, 34 White House Office of Management and Budget (OMB), 462 Whitman, Walt, 24 WHO. See World Health Organization whooping crane, 271f wilderness, 8, 270 regional environmental concerns, 8, 9f, 11-12 U.S. designation issues, 270, 272 Wilderness Act of 1964,

U.S., 270

wilderness north region of North America, 8, 9f wildlife habitat water-use planning and, 373 wildlife populations aquatic/wetland habitat preservation, 377-378, 380 sustainable management, 272-276 unsustainable harvests, 264 U.S. legislation, 459t Wildlife Protection Act (India), 6 erosive action, 315-316, 317f global patterns, 389f as weathering agent, 308 wind power, 169, 204-206 windbreaks, 320, 322f windrow composting systems, 428 wolves, management issues, 17, 267 air pollution and, 398 as energy source, 171-172,

173f, 175, 211-212 woodpeckers, endangered status, 259 World Bank, North Aral Sea project, 379 World Conservation Union (IUCN), 268 World Health Organization (WHO)

biomass consumption and

health outcomes, 176

·HIV/AIDS and, 164 Wyoming, gray wolf population management, 17

X

Xcel Energy, 169 Xerox Corporation, pollution prevention, 52

\mathbf{Y}

Yangtze River, Three Gorges Dam, 217 Yellowstone National Park bison introduction in, 269 Greater Yellowstone Ecosystem, 10 Yucca Mountain, nuclear waste disposal, 237

7

zebra mussel, 138, 265 Lake Champlain, 387 zero population growth, 152 freshwater ecosystem, 126, 127f Gulf of Mexico dead zone, 100, 381 marine ecosystem, 122, 127f vadose/zone of aeration, 355, 356f zoning laws land-use planning and, 294-295 urban sprawl and, 286

zooplankton, 122, 123f

MOT FOR SALE, BARTER OR EXCHANGE HANDLING CHARGES ONLY



PART I Environmental Science in a Social Context 2

CHAPTER 1 Environmental Interrelationships 4

CHAPTER 2 Environmental Ethics 19

CHAPTER 3 Risk and Cost: Elements of Decision Making 38

PART II Ecological Principles and Their Application 60

CHAPTER 4 Interrelated Scientific Principles: Matter, Energy, and Environment 62

CHAPTER 5 Interactions: Environments and Organisms 78
CHAPTER 6 Kinds of Ecosystems and Communities 104

CHAPTER 7 Population Principles 131
CHAPTER 8 Human Population Issues 148

PART III Energy 168

CHAPTER 9 Energy and Civilization: Patterns of Consumption 170

CHAPTER 10 Energy Sources 186

CHAPTER 11 Nuclear Energy: Benefits and Risks 220

PART IV Resource Management 244

CHAPTER 12 Biodiversity Issues 246

CHAPTER 13 Land-Use Planning 280

CHAPTER 14 Soil and Its Uses 305

CHAPTER 15 Agricultural Methods and Pest Management 329

CHAPTER 16 Water Management 352

PART V Pollution and Policy 386

CHAPTER 17 Air Quality Issues 388

CHAPTER 18 Solid Waste Management and Disposal 419

CHAPTER 19 Regulating Hazardous Materials 435

CHAPTER 20 Environmental Policy and Decision Making 452

glossary G-1 credits C-1 index I-1



Preface xv About the Authors xx Guided Tour xxii Critical Thinking xxv



PART I

Environmental Science in a Social Context 2 Can We Save Both Blue Crabs and Watermen? 3

CHAPTER 1

Environmental Interrelationships 4

The Field of Environmental Science 5
The Interrelated Nature of Environmental Problems 5

Environmental (lose-Up: Traditional Resource Use and Conflict Management in Keoladeo National Park, India—Science Versus Policy 6

An Ecosystem Approach 7

Regional Environmental Concerns 8

The Wilderness North 8
The Agricultural Middle 8

Environmental (lose-Up: The Greater Yellowstone Ecosystem 10

The Dry West .10

Global Perspective: Biodiversity, Human Welfare, and Economic Development 11

The Forested West 12
The Great Lakes and Industrial Northeast 12
The Diverse South 14

Global Perspective: Constraints and Risks of a Regional Approach—The Mekong River Delta Example 15

Issues—Analysis: The Fate of the Gray Wolf 17

CHAPTER 2 Environmental Ethics 19

Views of Nature 20 Environmental Ethics 21 Environmental Attitudes 22

Environmental (lose-Up: Naturalist Philosophers 23

Societal Environmental Ethics 24 Corporate Environmental Ethics 24

Environmental Close-Up: What's in Your Backyard? 25 Global Perspective: Chico Mendes and Extractive Reserves 27

Environmental Justice 27 Individual Environmental Ethics 29 Do We Consume Too Much? 29

Global Perspective: International Trade in Endangered Species 30

Food 31 Nature 31 Oil 31 Water 31 The Unknown 31

Global Environmental Ethics 32

Global Perspective: The Gray Whales of Neah Bay 34

Issues—Analysis: Environmental Dissent—Is Ecoterrorism Justified? 36

CHAPTER 3

Risk and Cost: Elements of Decision Making 38

Risk and Economics 39 Characterizing Risk 39 Risk Assessment 39 Risk Management 40

Environmental Close-Up: What's in a Number? 41

True and Perceived Risks 42

Economics in an Environmental Context 43

Resources 43

Supply and Demand 43

Assigning Value to Natural Resources 45

Kinds of Environmental Costs 45

Cost-Benefit Analysis 47

Concerns About the Use of Cost-Benefit Analysis 48 Comparing Economic and Ecological Systems 48

Common Property Resource Problems—The Tragedy of the Commons 49

Using Economic Tools to Address Environmental Issues 50 Subsidies 50

Market-Based Instruments 51

Global Perspective: Pollution Prevention Pays! 52

Life Cycle Analysis and Extended Product Responsibility 53

Environmental (lose-Up: Georgia Pacific Corporation: Recycled Urban Wood-A Case Study in Extended Product Responsibility 54

Economics and Sustainable Development 54 Economics, Environment, and Developing Nations 56 Issues-Analysis: The Economics and Risks of Mercury Contamination 58

PART II

Ecological Principles and Their Application 60 Imitating Mother Nature in a Florida Lake 61



CHAPTER 4

Interrelated Scientific Principles: Matter, Energy, and Environment 62

Scientific Thinking 63 The Scientific Method 63 Observation 63 Questioning and Exploring 63 Constructing Hypotheses 64 Testing Hypotheses 64 The Development of Theories and Laws 65 Limitations of Science 65

Environmental (lose-Up: Typical Household Chemicals 66

The Structure of Matter 67

Atomic Structure, 67 The Molecular Nature of Matter 67 Acids, Bases, and pH 68 Inorganic and Organic Matter 68 Chemical Reactions 69 Chemical Reactions in Living Things 70

Energy Principles 70 Kinds of Energy 70 States of Matter 71

First and Second Laws of Thermodynamics 71 Environmental Implications of Energy Flow 72

Issues—Analysis: Biofuels Technology 75

CHAPTER 5

Interactions: Environments and Organisms 78:

Ecological Concepts 79 Environment 79

> Limiting Factors 80 Habitat and Niche 80

The Role of Natural Selection and Evolution 82 Genes, Populations, and Species 82

Environmental (lose-Up: Habitat Conservation Plans: Tool or Token? 83

Natural Selection 83 Evolutionary Patterns 84 Kinds of Organism Interactions 86 Predation 86 Competition 86 Symbiotic Relationships 87 Some Relationships Are Difficult to Categorize 89 Human Interaction-A Different Look 89

Environmental Close-Up: Human Health and Exotic Species 90

Community and Ecosystem Interactions 90 Major Roles of Organisms in Ecosystems 91 Keystone Species 92

Energy Flow Through Ecosystems 92 Food Chains and Food Webs 93

Environmental (lose-Up: Contaminants in the Food Chain of Fish from the Great Lakes 95

Nutrient Cycles in Ecosystems—Biogeochemical Cycles 95 Human Impact on Nutrient Cycles 99

Issues—Analysis: Phosphate Mining in Nauru 101

CHAPTER 6 Kinds of Ecosystems and Communities 104

Succession 105

Primary Succession 105

Secondary Succession 108

Modern Concepts of Succession and Climax 108

Biomes: Major Types of Terrestrial Climax Communities 110

The Effect of Elevation on Climate and Vegetation 111

Desert 111 Grassland 112

Environmental (lose-Up: Grassland Succession 114

Mediterranean Shrublands (Chaparral) 114 Tropical Dry Forest 116

Tropical Rainforest 116

Global Perspective: Tropical Rainforests—A Special Case? 117

Temperate Deciduous Forest 118

Environmental (lose-Up: Protecting Old-Growth Temperate Rainforests of the Pacific Northwest 119

Taiga, Northern Coniferous Forest, or Boreal Forest 120 Tundra 120

Major Aquatic Ecosystems 121

Marine Ecosystems 121 Freshwater Ecosystems 126

Environmental (lose-Up: Non-native Invasive Aquatic Plants 126

Issues—Analysis: Ecosystem Loss in North America 129

CHAPTER 7 Population Principles 131

Population Characteristics 132 Natality and Mortality 132

Sex Ratio and Age Distribution 133

Population Density and Spatial Distribution 135

Summary of Factors That Influence Population Growth Rates 135

A Population Growth Curve 135

Carrying Capacity 136

Contents

Environmental (lose-Up: Population Growth of Invading Species 138

Reproductive Strategies and Population Fluctuations 139 Human Population Growth 140

Available Raw Materials 141 Available Energy 142 Waste Disposal 142 Interaction with Other Organisms 142 Social Factors Influence Human Population 142 Ultimate Size Limitation 142

Global Perspective: Managing Elephant Populations-Harvest or Birth Control? 143

Issues—Analysis: The Lesser Snow Goose—A Problem Population 145

CHAPTER 8 Human Population Issues 148

World Population Characteristics and Implications 149 Global Perspective: Thomas Malthus and His Essay on Population 150

Factors That Influence Population Growth 150 Biological Factors 151 Social Factors 152 Political Factors 153

Population Growth and Standard of Living 155 Population and Poverty—A Vicious Cycle? 156 Hunger, Food Production, and Environmental Degradation 156

Global Perspective: The Grameen Bank and Microcredit 157 The Demographic Transition Concept 159

Global Perspective: The Urbanization of the World's Population 160

The U.S. Population Picture 160

Likely Consequences of Continued Population Growth 162

Global Perspective: North America—Population Comparisons 163

Global Perspective: The Impact of AIDS on Populations 164 Issues-Analysis: Demography, Aging Populations, and Public Policy 165

PART III

Energy 168 Winds of Change 169

CHAPTER 9 Energy and Civilization: Patterns of Consumption 170

History of Energy Consumption 171 Biological Energy Sources 171 Increased Use of Wood 171 Fossil Facts and the Industrial Revolution 172 The Role of the Automobile 173

Global Perspective: Reducing Automobile Use in Cities 174

Growth in the Use of Natural Gas 174

How Energy Is Used 174

Residential and Commercial Energy Use 175

Global Perspective: Biomass Fuels and the Developing World 176

Industrial Energy Use 176 Transportation Energy Use 176

Electrical Energy 177

The Economics and Politics of Energy Use 177

Fuel Economy and Government Policy 178 The Importance of OPEC 179

Energy Consumption Trends 181

Growth in Energy Use 181 Available Energy Sources 181 Political and Economic Factors 181

Environmental (lose-Up: Alternative-Fuel Vehicles 183

Issues—Analysis: Are Hybrid Electric Vehicles the Answer? 184

CHAPTER 10

Energy Sources 186

Energy Sources 187 Resources and Reserves 187

> Global Perspective: Potential World Petroleum Resources 189

Fossil-Fuel Formation 189

Coal 189

Oil and Natural Gas 190

Issues Related to the Use of Fossil Fuels 191

Coal Use 191 Oil Use 193

The Arctic National Wildlife Refuge and Oil 195

Natural Gas Use 196

Renewable Sources of Energy 197

Hydroelectric Power 197

Global Perspective: Energy Development in China 200

Tidal Power 201 Geothermal Power 203 Wind Power 204 Solar Energy 206 Biomass Conversion 208 Fuelwood 211 Solid Waste 212

Energy Conservation 213 The Hydrogen Economy 214

Global Perspective: The Three Gorges Dam 217

Issues-Analysis: Public Perceptions of Energy 218

CHAPTER 11

Nuclear Energy: Benefits and Risks 220

The Nature of Nuclear Energy 221 The History of Nuclear Energy Development 222 Nuclear Fission Reactors 22 Plans for New Reactors Worldwide 224

Plant Life Extension 225

Contents

Investigating Nuclear Alternatives 226
Breeder Reactors 226

Nuclear Fusion 227

The Nuclear Fuel Cycle 227

Nuclear Material and Weapons Production 228

Nuclear Power Concerns 229

Reactor Safety: The Effects of Three Mile Island and Chernobyl 230

Global Perspective: The Nuclear Legacy of the Soviet Union 231

Exposure to Radiation 233
Thermal Pollution 233
Decommissioning Costs 234

Radioactive Waste Disposal 236

The Politics of Nuclear Power 238

Developments in Asia 239

Environmental Close-Up: The Hanford Facility: A Storehouse of Nuclear Remains 240

Issues—Analysis: Predicting the Future of Nuclear Power 242



Resource Management 244
Natural Community Conservation
Planning 245



CHAPTER 12

· Biodiversity Issues 246

Biodiversity Loss and Extinction 247

Causes of Extinction 247

Extinction as a Result of Human Activity 247

Describing Biodiversity 248

Genetic Diversity 248

Species Diversity 249

Ecosystem Diversity 249

The Value of Biodiversity 250

Biological and Ecosystem Services Values 250

Global Perspective: Biodiversity "Hot Spots" 251

Direct Economic Values 254

Ethical Values 255

Threats to Biodiversity 255

Habitat Loss 255

Overexploitation 261

Introduction of Exotic Species 264

Control of Pest Organisms 266

Environmental Close-Up: The Northern Spotted Owl 268

What Is Being Done to Preserve Biodiversity? 268

Global Perspective: The History of the Bison 269

Legal Protection 269

Sustainable Management of Wildlife Populations 272

Environmental (lose-Up: The California Condor 275

Sustainable Management of Fish Populations 275

Issues-Analysis: The Problem of Image 277

CHAPTER 13

Land-Use Planning 280

The Need for Planning 281

Historical Forces That Shaped Land Use in North America 281

The Importance of Waterways 281

The Rural-to-Urban Shift 281

Global Perspective: Urbanization in the Developing World 283

Migration from the Central City to the Suburbs 283

Factors That Contribute to Sprawl 285

Lifestyle Factors 286

Economic Factors 286

Planning and Policy Factors 286

Problems Associated with Unplanned Urban Growth 287

Transportation Problems 287

Air Pollution 287

Low Energy Efficiency 287

Loss of Sense of Community 287

Death of the Central City 288

Higher Infrastructure Costs 288

Loss of Open Space 288

Loss of Farmland 288

Water Pollution Problems 288

Floodplain Problems 288

Wetlands Misuse 289

Other Land-Use Considerations 290

Land-Use Planning Principles 290

Environmental (lose-Up: Wetlands Loss in Louisiana 291

Environmental (lose-Up: Farmland Preservation in Pennsylvania 292

Mechanisms for Implementing Land-Use Plans 292

Establishing State or Regional Planning Agencies 293

Purchasing Land or Use Rights 294

Regulating Use 294

Special Urban Planning Issues 295

Urban Transportation Planning 295

Environmental (lose-Up: Land-Use Planning and Aesthetic Pollution 296

Urban Recreation Planning 297

Redevelopment of Inner-City Areas 297

Smart Growth 299

Federal Government Land-Use Issues 299

Issue—Analysis: Smart Growth Winners 302

CHAPTER 14

Soil and Its Uses 305

Geologic Processes 306

Soil and Land 308

Soil Formation 309

Soil Properties 310

Son Properties 510

Soil Profile 312

Soil Erosion 315

Soil Conservation Practices 316

Environmental (lose-Up: Desertification and Global Security 318

xi

Environmental Close-Up: The Conservation Security . Program 319

Contour Farming 319 Strip Farming 319 Terracing 320 Waterways 320 Windbreaks 320

Conventional Versus Conservation Tillage 320

Protecting Soil on Nonfarm Land 323

Environmental (lose-Up: Land Capability Classes 324 Global Perspective: Worldwide Soil Degradation 326

Issues—Analysis: Soil Fertility and Hunger in Africa 327

CHAPTER 15

Agricultural Methods and Pest Management 329

The Development of Agriculture 330 Shifting Agriculture 330 Labor-Intensive Agriculture 330 Mechanized Agriculture 331

Fossil Fuel Versus Muscle Power 332

The Impact of Fertilizer 332 Agricultural Chemical Use 333

Environmental Close-Up: DDT—A Historical Perspective 334

Insecticides 334 Herbicides 335 Fungicides and Rodenticides 336

Environmental (lose-Up: A New Generation of Insecticides 337

Other Agricultural Chemicals 337 Problems with Pesticide Use 337

Persistence 337

Bioaccumulation and Biomagnification 338

Pesticide Resistance 339

Global Perspective: Economic Development and Food Production in China 340

Global Perspective: Contaminated Soils in the Former Soviet Union 341

Effects on Nontarget Organisms 341 Human Health Concerns 342

Why Are Pesticides So Widely Used? 342

Environmental (lose-Up: Industrial Production of Livestock 343

Alternatives to Conventional Agriculture 343

Environmental Close-Up: Food Additives 344

Techniques for Protecting Soil and Water Resources 344 Integrated Pest Management 345

Issues-Analysis: What Are Organic Foods? 349

CHAPTER 16 Water Management 352

The Water Issue 353 The Hydrologic Cycle 354. Human Influences on the Hydrologic Cycle 355 Kinds of Water Use 356

Domestic Use of Water 357 Agricultural Use of Water 358 Industrial Use of Water 359 In-Stream Use of Water 360

Environmental Close-Up: The California Water Plan 361

Global Perspective: Comparing Water Use and Pollution in Industrialized and Developing Countries 363

Kinds and Sources of Water Pollution 364

Municipal Water Pollution 366

Global Perspective: The CleanUp of the Holy Ganges 367

Agricultural Water Pollution 368 Industrial Water Pollution 368 Thermal Pollution 369 Marine Oil Pollution 369 Groundwater Pollution 369

Water-Use Planning Issues 371

Water Diversion 372 Wastewater Treatment 373

Environmental (lose-Up: Restoring the Everglades 375

Salinization 376 Groundwater Mining 376

Preserving Scenic Water Areas and Wildlife Habitats 377

Global Perspective: Death of a Sea 379

Global Perspective: The Dead Zone of the Gulf of

Mexico 381

Issues—Analysis: Is There Lead in Our Drinking Water? 383

PART V

Pollution and Policy 386 Lake Champlain: It Isn't Easy Stayin' Clean 387



CHAPTER 17

Air Quality Issues 388

The Atmosphere 389 Pollution of the Atmosphere 390 Categories of Air Pollutants 390 Carbon Monoxide 391 Particulate Matter 392

Global Perspective: Air Pollution in Mexico City 392

Sulfur Dioxide 393 Nitrogen Dioxide 393 Lead 393 Volatile Organic Compounds 394 Ground-Level Ozone and Photochemical Smog 394 Hazardous Air Pollutants 397

Control of Air Pollution 397 Motor Vehicle Emissions 397 Particulate Matter Emissions 398 Power Plant Emissions 398

Environmental Close-Up: Noise Pollution 399

The Clean Air Act 400 Acid Deposition 400

xii

Contents

Ozone Depletion 403

Global Warming and Climate Change 403

Environmental (lose-Up: Secondhand Smoke 404

Causes of Global Warming and Climate Change 405

Potential Consequences of Global Warming and Climate Change 407

Addressing Climate Change 410

Energy Efficiency 410

The Role of Biomass 410

Political and Economic Forces 410

Indoor Air Pollution 411

Global Perspective: The Kyoto Protocol on Greenhouse Gases 412

Environmental Close-Up: Radon 414

Issues-Analysis: Pollution, Policy, and Personal Choice 417

CHAPTER 18

Solid Waste Management and Disposal 419

Kinds of Solid Waste 420 Municipal Solid Waste 420

Environmental Close-Up: Mountain Top Removal 422

Methods of Waste Disposal 422

Landfills 423

Incineration 424

Producing Mulch and Compost 426

Environmental (lose-Up: Resins Used in Consumer Packaging 427

Source Reduction 428

Environmental (lose-Up: What You Can Do to Reduce Waste and Save Money 429

Recycling 429

Environmental (lose-Up: Recycling Is Big Business 431

Issues-Analysis: Paper or Plastic? 433

CHAPTER 19

Regulating Hazardous Materials 435

Hazardous and Toxic Materials in Our Environment 436 Hazardous and Toxic Substances—Some Definitions 436

Defining Hazardous Waste 437

Issues Involved in Setting Regulations 438

Identification of Hazardous and Toxic Materials 438

Environmental (lose-Up: Determining Toxicity 439

Setting Exposure Limits 439

Acute and Chronic Toxicity 439

Synergism 440

Persistent and Nonpersistent Pollutants 440

Environmental Problems Caused by Hazardous Wastes 440

Global Perspective: Lead and Mercury Poisoning 441

Health Risks Associated with Hazardous Wastes 442 Hazardous-Waste Dumps—A Legacy of Abuse 443

Environmental (lose-Up: Computers—A Hazardous Waste 444

Toxic Chemical Releases 444

Hazardous-Waste Management Choices 444

Reducing the Amount of Waste at the Source 446

Recycling Wastes 446

Treating Wastes 446

Disposal Methods 446

International Trade in Hazardous Wastes 447

Global Perspective: Hazardous Wastes and Toxic Materials in China 448

Hazardous-Waste Management Program Evolution 449 Issues—Analysis: Household Hazardous Waste 450

CHAPTER 20

Environmental Policy and Decision Making 452

New Challenges for a New Century 453

Governance and Government 454

Learning from the Past 455

Thinking About the Future 455

Defining the Future 456

The Development of Environmental Policy in the

United States 457

The Changing Nature of Environmental Policy 460

Environmental Policy and Regulation 460

The Greening of Geopolitics 463

Environmental (lose-Up: Changing the Nature of Environmental Regulation—The Safe Drinking Water Act 464

Terrorism and the Environment 465

International Environmental Policy 468

Global Perspective: ISO Standards for Environmental

Management Systems 469

Global Perspective: Overview of an International Organization—The International Whaling Commission 470

Earth Summit on Environment and Development 472

Environmental Policy and the European Union 472

New International Instruments 473

It All Comes Back to You 474

Issues—Analysis: Gasoline, Taxes, and the Environment 475

glossary G-1 credits C-1

index I-1